ARIZONA WATER ATLAS
VOLUME 3 –SOUTHEASTERN ARIZONA PLANNING AREA (Draft)

Preface

Volume 3, the Southeastern Arizona Planning Area, is the third in a series of nine volumes that comprise the Arizona Water Atlas. The primary objectives in assembling the Atlas are to present an overview of water supply and demand conditions in Arizona, to provide water resource information for planning and resource development purposes, and help to identify the needs of communities.

The Atlas divides Arizona into seven planning areas (Figure 3.0-1). There is a separate Atlas volume for each planning area, an introductory volume composed of background information, and an executive summary volume. "Planning areas" are an organizational concept that provide for a regional perspective on supply, demand and water resource issues. A complete discussion of Atlas organization, purpose and scope is found in Volume 1.

There are additional, more detailed data available to those presented in this volume. They may be obtained by contacting the Arizona Department of Water Resources' Statewide Conservation and Strategic Planning Division.

3.0 Overview of the Southeastern Arizona Planning Area

The Southeastern Arizona Planning Area is composed of 14 groundwater basins that vary significantly in size. Elevation ranges from 10,713 feet at Mount Graham to 1,920 feet near Winkelman. Cochise County is entirely contained in the planning area as well as portions of seven other counties: Apache, Gila, Graham, Greenlee, Pima, Pinal and Santa Cruz counties. Most of the San Carlos Apache Reservation, the fourth largest reservation in Arizona, is located within the planning area in parts of six basins: Aravaipa Canyon, Bonita Creek, Dripping Springs Wash, Lower San Pedro, Morenci and Safford Basins. The 2000 Census planning area population was approximately 186,600. Basin population ranged from 21 in the Bonita Creek Basin to over 78,000 in the Upper San Pedro Basin. Sierra Vista is the largest metropolitan area with about 38,000 residents in the incorporated area and an additional 14,300 residents in the unincorporated area southeast of the city. The agricultural water use sector is the largest user with significant agricultural use in the Douglas, Safford and Willcox Basins. The Douglas Irrigation Non-expansion Area (INA), an area designated as having insufficient groundwater to provide a reasonably safe supply for irrigation, is located in the Douglas Basin. Major cities and towns, counties and the boundaries of the INA are shown on Figure 3.0-2.

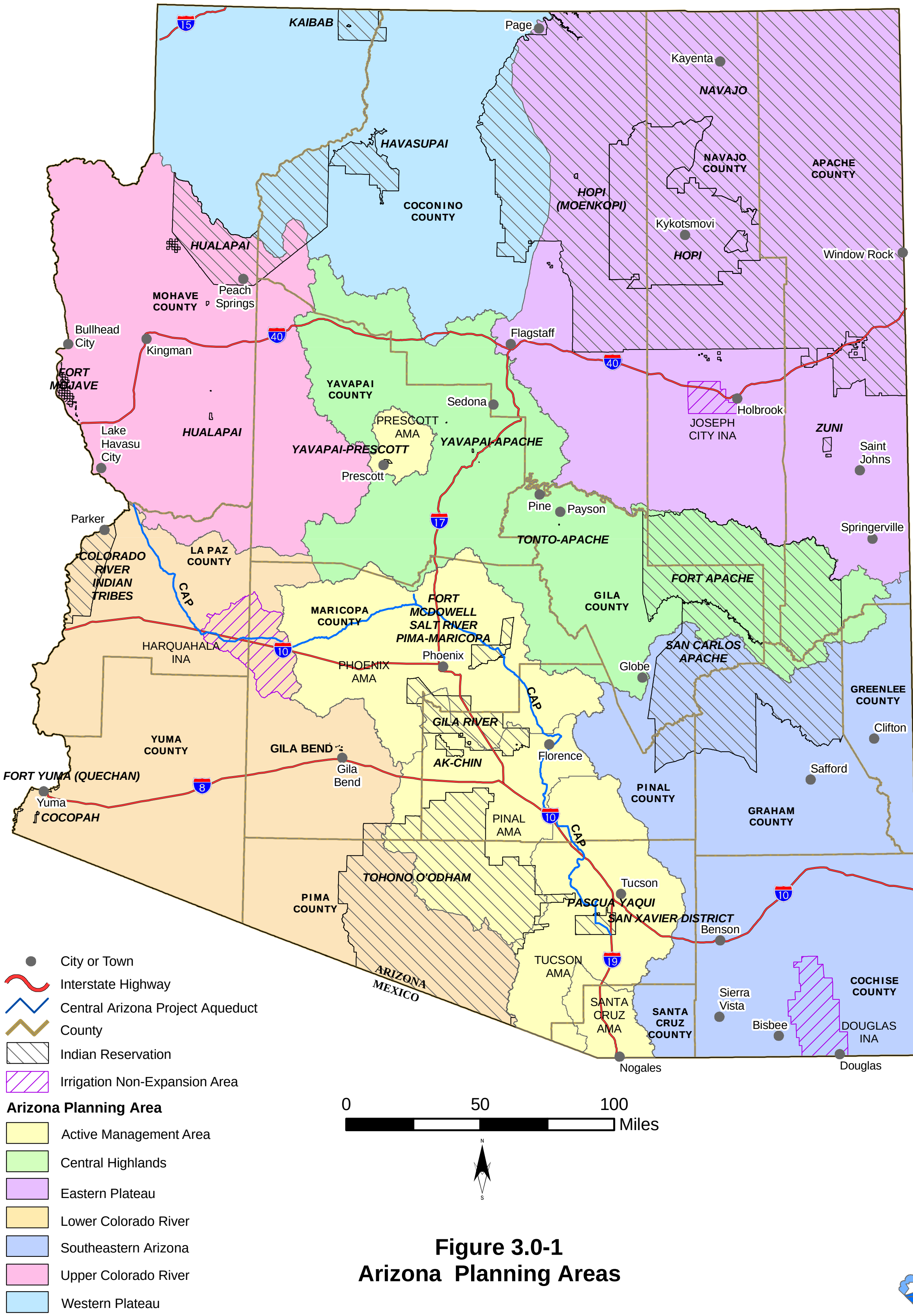


Figure 3.0-1
Arizona Planning Areas

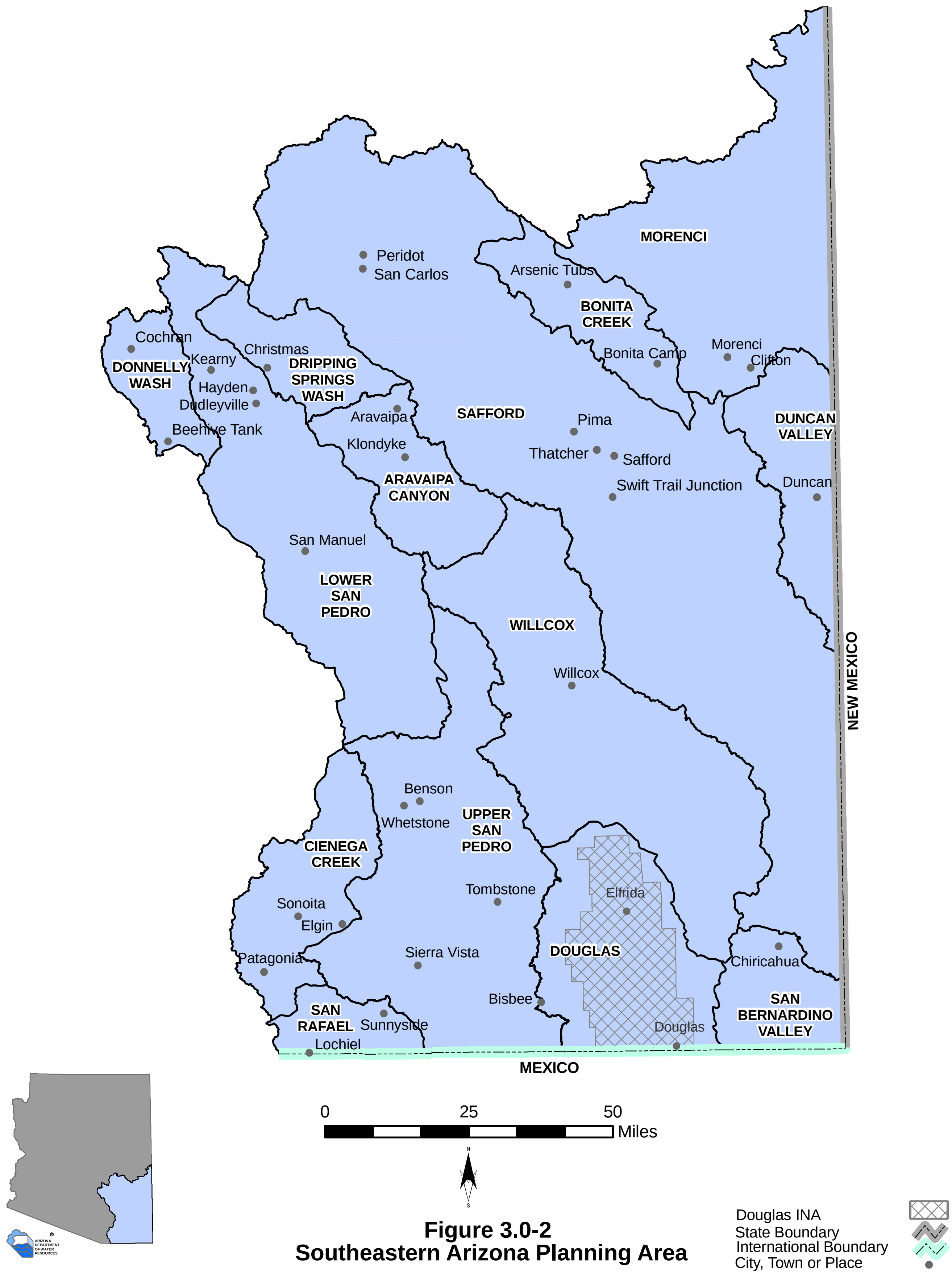


Figure 3.0-2
Southeastern Arizona Planning Area

3.0.1 Geography

The Southeastern Arizona Planning Area includes geographically diverse groundwater basins in the southeastern corner of Arizona. Groundwater basins include: Aravaipa Canyon, Bonita Creek, Cienega Creek, Donnelly Wash, Douglas, Dripping Springs Wash, Duncan Valley, Lower San Pedro, Morenci, Safford, San Bernardino Valley, San Rafael, Upper San Pedro and Willcox.

The planning area encompasses 16,072 sq. miles. It is bounded on the east by New Mexico, on the south by the international boundary with the state of Sonora, Mexico, on the west by the Active Management Area (AMA) Planning Area (Phoenix, Pinal, Santa Cruz and Tucson AMAs) and on the north by the Central Highlands Planning Area and a small portion of the Eastern Plateau Planning Area. Most of the 2,900 sq. mile San Carlos Apache Reservation, (83.1% or about 2,400 sq. miles), is located in the north central part of the planning area.

The majority of the planning area is within the Mexican Highland section of the Basin and Range physiographic province, which is characterized by northwest-southeast trending mountain ranges separated by broad alluvial valleys (See Volume 1, Figure 1-2). The Mexican Highland section is a higher elevation area of the province with valleys ranging from 2,500 to 4,000 feet above sea level and mountains and valleys covering about equal areas. The extreme northern portion of the planning area falls within the Central Highlands physiographic province, which is characterized by rugged mountains of igneous, metamorphic and sedimentary rocks. The average elevation in the planning area is 4,500 feet. Elevation ranges from 1,920 feet near Winkelman in the Lower San Pedro Basin to 10,713 feet at Mount Graham in the Pinaleño Mountains in the Safford Basin.

A unique feature of the planning area is mountain ranges that are isolated from each other by valleys of desert grasslands and desert scrub. These “sky islands” are part of a unique complex of about 27 mountain ranges in Arizona, New Mexico, and the Mexican States of Sonora and Chihuahua. The southwestern sky island complex extends from subtropical to temperate latitudes, a condition found nowhere else. (Warshall, 2006)

The planning area includes drainages of the San Pedro River and Upper Gila River. The Gila River originates in western New Mexico and enters Arizona near Duncan in the Duncan Valley Basin. The river generally flows west through the Safford Basin. The San Pedro River flows north from Mexico through the Upper and Lower San Pedro Basins and joins the Gila River at Winkelman. Surface water in the planning area flows into the Gila River except for the Willcox Basin, a “closed basin” with internal drainage, and several basins where drainage flows south into Mexico. These basins are the Douglas, San Rafael and San Bernardino Valley basins. The Santa Cruz River originates in the San Rafael Basin, flows south into Mexico, turns north and enters the Santa Cruz AMA east of Nogales. (ADWR, 1994a)

3.0.2 Hydrology[1]

Groundwater Hydrology

The Southeastern Arizona Planning Area is generally characterized by alluvial basins with large reserves of groundwater in gently sloping valleys separated by mountain ranges. Anderson, Freethy and Tucci (1992) divided the alluvial basins of south-central Arizona into five groups based on similar hydrologic and geologic characteristics. One of these, the “Southeast Basins”, covers much of the planning area. The principal water-bearing deposits in southeast basins are moderately thick sediments deposited prior to the formation of the Basin and Range structure and an overlying layer of lower basin fill to depths of over 1,000 feet, derived from the subsequent partial erosion of the ranges. Lower basin-fill sediments are composed of fine-grained to moderately fine-grained materials. Upper basin-fill deposits average about 300 feet in thickness and are composed of sands, gravels, silts, clays and some limestones. Thin layers of sand and gravel along major streams make up the stream alluvium. Aquifers in this region often consist of two or more water-bearing units separated by a fine-grained unit that forms a leaky confining layer over the lower basin fill. Groundwater generally flows from the basin margins to the central axis of the basin where most of the groundwater discharge occurs. There are also occurrences of confined groundwater (artesian conditions) within the lower basin fill. Artesian conditions occur in a number of locations in the planning area including: the vicinity of Artesia south of Safford, washes and terraces at the base of the Pinaleño Mountains, the vicinity of Saint David, in the San Bernardino Valley Basin and the Lower San Pedro Basin.

The major groundwater inflow components are mountain front recharge and stream infiltration with some underflow from adjacent up-gradient basins. Outflow consists of evapotranspiration, pumpage, discharge to streams as baseflow and some underflow to down-gradient basins, including into Mexico.

The north and northeastern basins of the planning area (Bonita Creek, Dripping Springs Wash, Duncan Valley and Morenci) contain major aquifers composed of stream alluvium, basin fill, volcanic rock and sedimentary rock (Gila Formation). These basins contribute groundwater flow to the Safford Basin. The Safford Basin is composed of three sub-basins. The southernmost sub-basin is the San Simon Valley sub-basin. In this sub-basin, groundwater is found under artesian conditions in the lower aquifer. The upper aquifer generally contains high total dissolved solids (TDS) and fluoride. In the Gila Valley sub-basin, located in the middle part of the Safford Basin, the principal aquifer is the younger basin fill. Groundwater is also utilized from the older basin fill, which generally is found under artesian conditions and where well discharges may be quite high. Groundwater in both the younger and older basin fill may be high in TDS in this sub-basin. The main water-bearing unit in the San Carlos Valley sub-basin, located in the northern part of the Safford Basin, is the younger stream alluvium.

In basins located on the western side of the planning area that are tributary to the San Pedro River (Aravaipa Canyon, Donnelly Wash, Lower and Upper San Pedro), groundwater is found in the

[1] Much of the information in this section is taken from the Arizona Water Resources Assessment, Volume 1, ADWR August, 1994.

stream alluvium and in basin-fill sediments. Both these aquifers are found in the Aravaipa Canyon Basin, while the principal aquifer in the Donnelly Wash Basin is a very narrow strip of basin fill alluvium. In the Upper San Pedro Basin, the basin fill is the principal aquifer although the stream alluvium is also utilized. An interesting feature in this basin is a limestone aquifer in the Whetstone Mountains that contains a "live" or wet cave, Kartchner Caverns, a state park. The water level in the cavern is about 700 feet higher than that of the underlying alluvial aquifer (ADWR, 2005a). In the Lower San Pedro Basin the hydrologic characteristics of the regional basin fill aquifer vary widely due to the amount of cementation and fine-grained layers. Artesian conditions exist about five miles north to ten miles south of Mammoth in wells drilled deeper than 500 feet. Water quality is generally suitable for most uses in these basins.

Hydrogeologic conditions in the Cienega Creek Basin are complex. The basin has been divided into three groundwater sections based on the presence of a distinctive aquifer or set of aquifers: upper Cienega Creek, lower Cienega Creek and Sonoita Creek. The main aquifer in the upper Cienega Creek section, which includes most of the basin's central valley, is the basin fill alluvium. In the lower Cienega Creek section, which coincides with the surface water divide at "the Narrows" on Cienega Creek, north to the basin boundary, there are three aquifers: stream alluvium, basin fill and the Pantano formation. The main aquifer in this section is the stream alluvium. The basin-fill alluvium is a poor aquifer in this section with relatively low well yields and interbedded clay layers that create a leaky, confined aquifer and artesian conditions. The southwestern section of the basin is the Sonoita Creek section where the main aquifer is the stream alluvium that forms the floodplain of Sonoita Creek and its tributaries. Groundwater quality is generally good throughout the basin.

The Willcox Basin is a "closed basin" with no groundwater inflow or outflow from adjacent basins. Groundwater is found in alluvial deposits consisting of stream and lake-bed deposits. The stream deposits are the most productive water-bearing unit. The lake bed deposits are mainly clay that outcrop in the Willcox Playa. There they create localized artesian conditions. Where the coarse-grained stream deposits are underlain by the lake-bed deposits, perched groundwater conditions may occur. Groundwater flow conditions have been altered significantly due to groundwater pumping. Declines in groundwater levels (in excess of 200 feet measured in nine wells between 1954 and 1975), may have caused land subsidence in the basin (USGS, 2006a). High TDS concentrations exist in some areas (ADWR, 1994b) and exceedences of fluoride and arsenic have been reported in a number of wells.

Groundwater from three basins (San Bernardino Valley, Douglas and San Rafael) flows into Mexico. The Douglas and San Bernardino Valley Basins contain volcanic rock that serves as an aquifer material. There is a long alluvial valley in the Douglas Basin where the main aquifer is the basin fill. In the vicinity of Elfrida, groundwater flow directions have been altered due to agricultural pumpage. The major aquifer in the San Rafael Basin is stream alluvium and basin fill, which are hydrologically connected. Groundwater quality is generally suitable for most uses in these basins. More detail on the hydrogeology of each basin is described in the groundwater conditions section for each basin.

Surface Water Hydrology

Surface water in the planning area can generally be divided into four areas: the Upper Gila River drainage basins, the Middle Gila River/San Pedro River drainage, the Willcox Basin and areas that drain into Mexico.

The Upper Gila watershed drains about 7,400 square miles in the planning area above Coolidge Dam and is within the Morenci, Duncan Valley, Bonita Creek and Safford basins. Major tributaries include the San Francisco River, Eagle Creek, Bonita Creek, San Simon Creek and the San Carlos River.

An average of about 160,000 acre-feet per year of Gila River water flows into Arizona from New Mexico and over 40% of this flow typically occurs in the winter. Tributary inflows from the San Francisco River are significant, typically over 150,000 acre-feet per year (ADWR, 2006). The San Francisco River is perennial with a number of hot springs located above Clifton. The Gila River has a 35-mile perennial stretch about 20 miles west of the New Mexico border. Flow in this stretch is maintained by tributary inflow and springs, including hot springs (ADWR, 1994b). Flow in the Gila River becomes intermittent farther downstream due to seasonal variations in flow and impoundment in San Carlos Reservoir. Inflow to the San Carlos Reservoir from the Gila and San Carlos Rivers averages about 310,000 acre-feet per year. (ADWR, 2006).

The largest spring in the planning area is located in the Safford Basin. Warm Springs, with a measured discharge of almost 3,400 gpm is located at the headwaters of the San Carlos River. There are also a number of large springs downstream from Pima near the Gila River (USGS, 2006b).

Below Coolidge Dam, flow in the Gila River is from releases from the San Carlos Reservoir and flood flow from the San Pedro River, the only major tributary in this stretch of the Gila River located within the Southeastern Arizona Planning Area (ADWR, 1994b). Since 1936, an average of 260,000 acre-feet per year of reservoir storage and inflows have been released to the river below Coolidge Dam (ADWR, 2006). Dripping Springs Wash and Donnelly Wash Basins are included in the Middle Gila River drainage as are the basins of the San Pedro River drainage. Basins within the San Pedro River drainage include Aravaipa Canyon, and the Upper and Lower San Pedro Basins. The Cienega Creek and San Rafael groundwater basins contribute tributary surface water to the San Pedro River drainage (ADWR, 1991). Surface water flow in the Cienega Creek Basin also drains to the Santa Cruz River.

Some stretches of the San Pedro River are perennial, although recent drought and delay of the summer monsoon has affected some previously perennial stretches for short periods of time, most notably at Charleston in the Upper San Pedro Basin. Major tributaries to the San Pedro River are the Babocomari River and Aravaipa Creek. In this drainage there are fairly productive springs in the Huachuca Mountains and in the vicinity of the San Pedro River in the Lower San Pedro Basin.

Surface water drainage in the Willcox Basin is to the Willcox Playa, which occupies about 50 square miles in the center of the basin. A playa is a nearly level area at the bottom of a closed desert basin, sometimes temporarily covered by water. There are a few perennial streams in the basin that originate in the Pinaleño and the Chiricahua Mountains. Perennial streams include Grant, Leslie, Turkey and Rucker Creeks. There are no large springs identified in the basin.

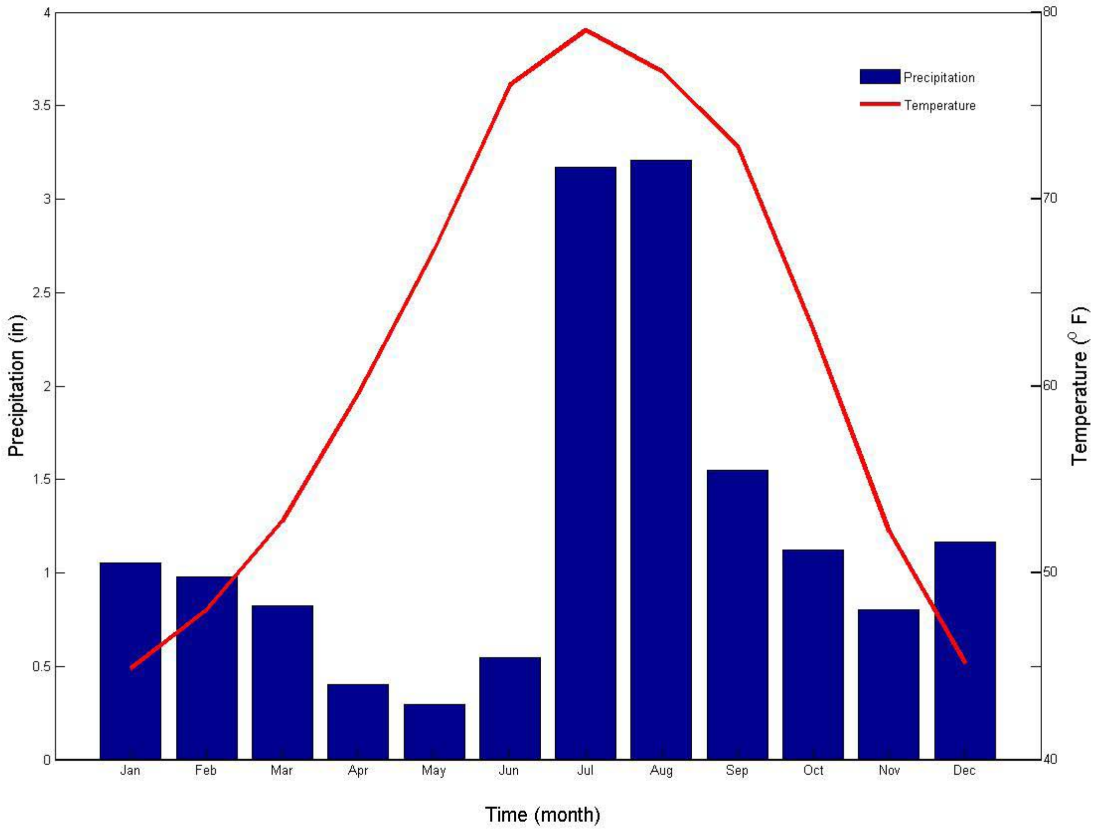
The Douglas, San Bernardino Valley and San Rafael Valley basins generally drain south into Mexico. Whitewater Draw is the major drainage in the Douglas Basin. Black Draw is the main surface water drainage in the San Bernardino Valley Basin and becomes perennial just north of the international boundary. In this basin, artesian wells and springs support wetlands. The San Rafael Valley contains a surface water divide that separates the drainage into two watersheds. Most of the Valley is drained by the Santa Cruz River that flows south into Mexico, then north into Arizona east of Nogales. The eastern part of the valley drains south to Mexico into the San Pedro River Watershed and San Pedro River, which flows north into the planning area. There are no major springs (>10 gpm) identified in any of the three Mexican drainage basins.

3.0.3 Climate

Annual average precipitation in the planning area is 14.7 inches, with over 52% coming in July, August, and September (Figure 3.0-3). This planning area receives the most summer precipitation in the state because of its proximity to the core monsoon region in Mexico. The monsoon is strongest in northwestern Mexico, and Arizona usually only receives the northernmost fringes of precipitation. However, Pool and Coes (1999) noted that trends in seasonal precipitation at four stations in the southern half of the Upper San Pedro Basin showed a general trend of increasing winter precipitation and decreasing wet-season (summer) precipitation during the period 1956-1997. Figure 3.0-4 shows seasonal precipitation averages for selected basins in the planning area that illustrates seasonal precipitation variability as well as climatic differences between basins.

Summer precipitation from thunderstorms is less hydrologically efficient than winter precipitation, because monsoon storm cells are spatially discontinuous and high summer temperatures result in high evaporation rates. About 35% of planning area precipitation occurs during winter months (November – April), mostly from frontal storm systems. At higher elevations, this precipitation falls as snow. Slow water release from high elevation spring snowmelt and low evaporation rates make winter precipitation more hydrologically efficient because there is less runoff and greater gain to streams.

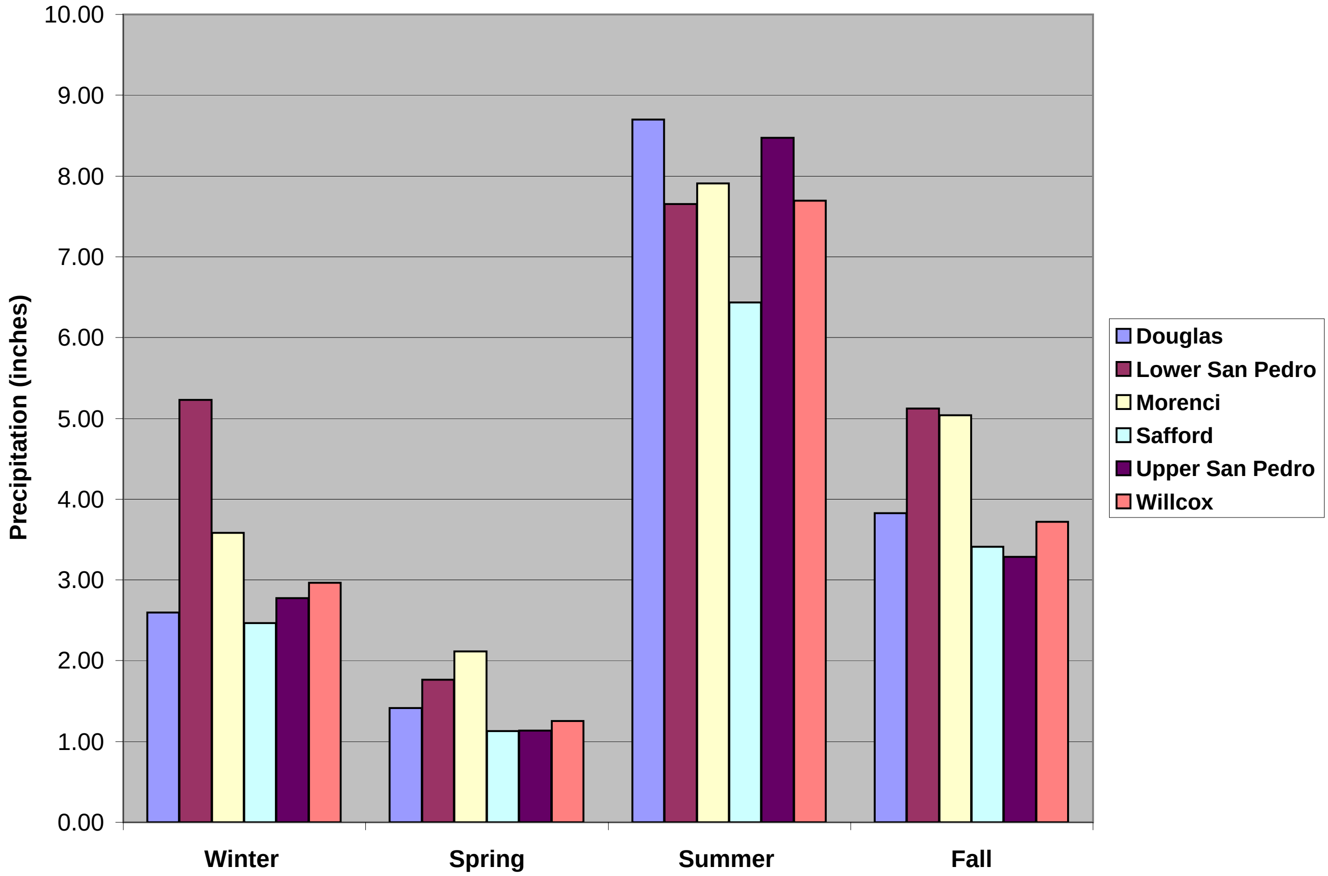
Figure 3.0-3 Average monthly precipitation and temperature in the Southeastern Arizona Planning Area, 1930-2002



Data are from selected Western Regional Climate Center cooperative weather observation stations. Figure author: Ben Crawford, CLIMAS.

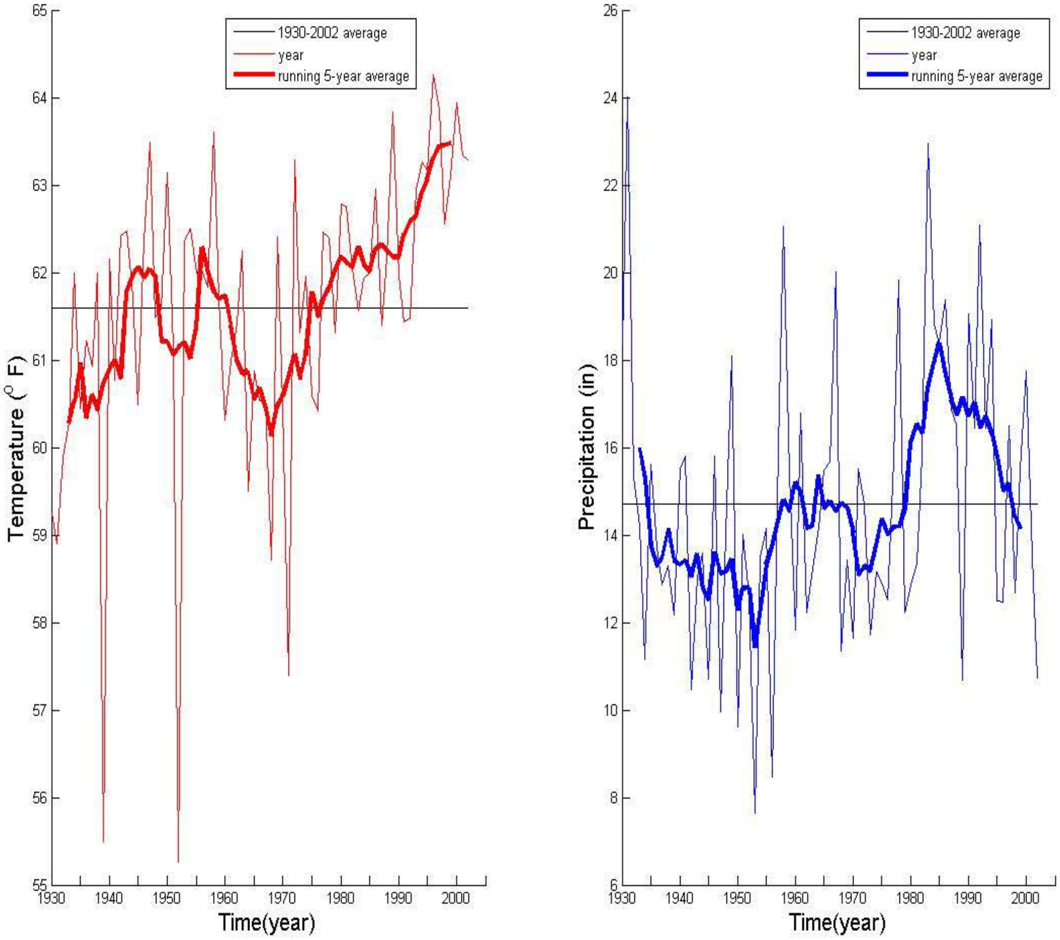
As in other areas of Arizona, precipitation is extremely variable, both spatially and from year to year. For example, during the 2005-2006 winter, the planning area received 6.3 inches less precipitation than during the 2004-2005 winter. This variability can also be observed on longer time scales. The 1950s were a relatively dry decade with an average annual precipitation deficit of -1.46 inches, while the 1980s were a relatively wet decade with an average annual precipitation surplus of 1.86 inches (Figure 3.0-5). Winter precipitation records dating to 1000 A.D. reconstructed from tree rings show extended periods of above and below average precipitation in every century (Figure 3.0-6).

Figure 3.0-4 Average annual precipitation for selected basins in the Southeastern Arizona Planning Area



These decadal and shorter time period shifts are related to circulation changes in the Pacific Ocean. On time scales of 10-30 years, precipitation variability is likely related to shifts in Pacific Ocean circulation patterns, such as the El Niño-Southern Oscillation (ENSO) or the Pacific Decadal Oscillation (PDO). On time scales of 2-7 years, the ENSO, with its phases of El Niño and La Niña, is associated with precipitation variations in the region, most notably during winter months (November-April). During El Niño episodes, there are greater chances for above-average winter precipitation, while La Niña conditions are usually associated with below-average winter precipitation. However, El Niño winters can also produce below-average precipitation. Generally, La Niña conditions are associated with drought in the region. The ENSO phases also impact precipitation and monsoon strength in the region.

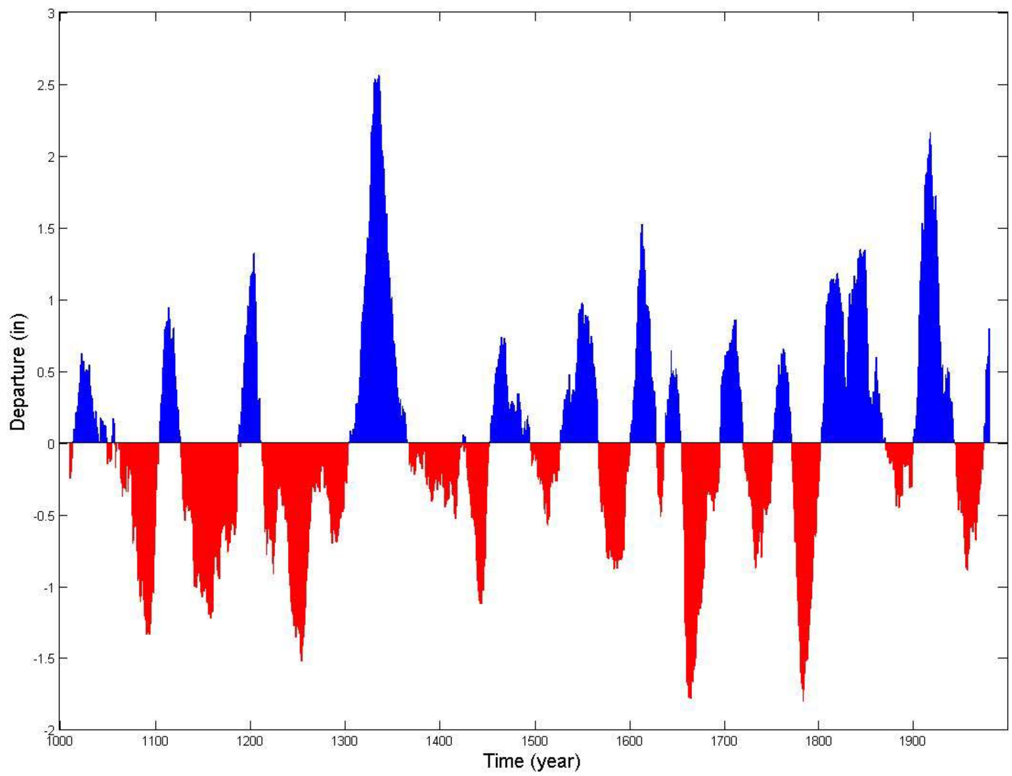
Figure 3.0-5 Average temperature (left) and total precipitation in the Southeastern Arizona Planning Area from 1930-2002



Horizontal lines are average temperature (61.6 °F) and precipitation (14.7 inches), respectively. Light lines are yearly values and highlighted lines are 5-year moving average values. Data are from selected Western Regional Climate Center cooperative weather observation stations. Figure author: Ben Crawford, CLIMAS.

Annual average temperature in the planning area is 61.6° F, compared to the statewide average of 59.9° F. As in other parts of Arizona, temperatures have been increasing the past several decades (Figure 3.0-5). Temperature observations are consistent with global temperature trends; however, some warming may be attributed to changes in land-cover resulting from population growth.

Figure 3.0-6 Arizona NOAA climate division 7 (southeastern Arizona; Graham, Greenlee, Cochise, Santa Cruz, and Pima Counties) winter (November-April) precipitation departures from average, 1000-1988, reconstructed from tree rings



Data are presented as a 20-year moving average to show variability on decadal time scales. Values shown for each year are centered on a 20 year period. The average winter precipitation for 1000-1988 is 4.9 inches. Data: Fenbiao Ni, University of Arizona Laboratory of Tree-Ring Research and CLIMAS. Figure author: Ben Crawford, CLIMAS.

3.0.4 Environmental Conditions

Environmental conditions reflect the impacts of geography, climate and cultural activities and may be a critical consideration in water resource management and supply development. Discussed in this section are historic conditions, the effect of cultural activities on environmental conditions, and actions undertaken to restore and protect water resources and habitat.

Biotic communities in the Southeastern Arizona Planning Area range from Upland Sonoran to Subalpine conifer forests. Much of the area is semi-desert grassland and Chihuahuan desert. The sky island ecosystems of the planning area are relatively isolated from each other, and as a result there are a high number of endemic species in the planning area mountain ranges. These ecosystems are of major interest to resource managers due to their biological diversity and distinct biogeography. (Warshall, 2006)

The planning area has been substantially altered in many locations by grazing and farming activities. Cultural water use has lowered groundwater levels and surface water diversions and impoundments have impacted streamflow in a number of areas. On Bonita Creek, woodcutting for mines, overgrazing, beaver trapping and a water conveyance system to Safford has reportedly reduced topsoil as much as 50% and down cut the creek as much as 12 feet (Tellman, et al, 1997). The Gila River, which once was perennial for most of its length in Arizona has been altered in the planning area by Coolidge dam and farming activities. The San Pedro River was a broad river of cienegas (marshes) when first observed by Spanish expeditions in the 1600s and 1700s. Stream entrenchment began in the 1880s and by the early 1890s had spread along the length of the river. The San Pedro River channel began to stabilize during the 1950s (ADWR, 2005a). Historically, the San Simon River was a broad intermittent stream that meandered through the San Simon Valley. Settlers channelized the river in the 1880s to control flooding and direct its flow until it eventually became a 60 mile long, 600 to 800 foot wide river, 10 to 30 feet deep. Restoration efforts began in the 1930s and numerous erosion control structures have been built on the river. (Tellman, et al, 1997)

Arizona Water Protection Fund Programs

Forty riparian restoration projects in the Southeastern Arizona Planning Area have been funded by the Arizona Water Protection Fund Program (AWPF) through 2005. The objective of the AWPF program is to provide funds for protection and restoration of Arizona's rivers and streams and associated riparian habitats. There are funded projects in ten of the fourteen planning area basins. Most projects have been funded in the Safford, Upper San Pedro, Cienega Creek and Lower San Pedro Basins. Many of these projects were for the purpose of fencing, often in conjunction with water development, and for research. A list of projects and types of projects funded in the Southeastern Arizona Planning Area through 2005 is found in Appendix A of this volume. (A description of the program, a complete listing of all projects funded, and a reference map is found in Appendix C of Volume 1.)

Instream Flow Claims

An instream flow right is a non-diversionary appropriation of surface water for recreation and wildlife use. Thirty-four applications for instream flow claims have been filed in the Southeastern Arizona Planning Area, listed in Table 3.0-1 and shown on Figure 3.0-7. Claims have been filed in nine of the fourteen planning area basins. Certificates have been issued for claims on Aravaipa Creek in the Aravaipa Canyon and Lower San Pedro Basins; Bass Canyon in the Lower and Upper San Pedro Basins; Hot Springs Canyon and Wildcat Canyon in the Lower San Pedro Basin; Leslie Creek in the Douglas Basin; Mescal Creek in the Dripping Springs Wash Basin; and O'Donnell Creek, Ramsey Canyon and the San Pedro River in the Upper San Pedro Basin. Other basins with instream flow applications are Bonita Creek, Duncan Valley, Morenci and Safford.

Table 3.0-1 Instream Flow Claims in the Southeastern Arizona Planning Area

Map Key	Stream	Applicant	Application No.	Permit No.	Certificate No.	Filing Date
1	Aravaipa Creek	BLM (Phoenix)	33-87114.0	87114	87114	6/1/1981
2	Aravaipa Creek	The Nature Conservancy	33-95488.0	95488	95488	10/31/1990
3	Aravaipa Creek	The Nature Conservancy	33-95489.0	95489	95489	10/31/1990
4	Aravaipa Creek	The Nature Conservancy	33-95490.0	95490	95490	10/31/1990
5	Aravaipa Creek	The Nature Conservancy	33-95771.0	95771	95771	10/31/1990
6	Babocomari River	BLM (Safford)	33-95487.0	Pending	Pending	10/2/1990
7	Babocomari River	BLM (Safford)	33-96167.0	Pending	Pending	2/3/1992
8	Bass Canyon	BLM (Safford)	33-94371.0	94371	94371	12/1/1988
9	Bass Canyon	The Nature Conservancy	33-96278.0	96278	96278	12/1/1988
10	Bonita Creek	BLM (Safford)	33-90250.0	Pending	Pending	10/21/1985
11	Buehman Canyon	Arizona State Land Department	33-90249.1	Pending	Pending	10/21/1985
12	Buehman Creek	The Nature Conservancy	33-96545.0	Pending	Pending	3/4/1997
13	Gila River	BLM (Safford)	33-94379.0	Pending	Pending	12/14/1988
14	Hot Springs Canyon	BLM (Safford)	33-94372.0	94372	94372	12/1/1988
15	Hot Springs Canyon	The Nature Conservancy	33-96279.0	96279	96279	12/1/1988
16	Leslie Creek	U.S. Fish & Wildlife Service	33-96176.0	96176	96176	3/20/1992
17	Mescal Creek	BLM (Phoenix)	33-90252.0	90252	90252	10/21/1985
18	Miller Canyon Draw	Coronado National Forest	33-95366.0	Pending	Pending	12/29/1989
19	Oak Grove Canyon	BLM (Safford)	33-96811.0	Pending	Pending	7/21/2005
20	O’Donnell Creek	The Nature Conservancy	33-78421.0	78421	78421	6/27/1979
21	O’Donnell Creek	The Nature Conservancy	33-96449.0	96449	96449	2/21/1991
22	Peppersauce Creek	Murray, William L.	33-96564.0	Pending	Pending	8/6/1997
23	Ramsey Creek	The Nature Conservancy	33-78419.0	78419	78419	6/27/1979

Map Key	Stream	Applicant	Application No.	Permit No.	Certificate No.	Filing Date
24	Redfield Canyon	BLM (Safford)	33-94369.0	Pending	Pending	12/1/1988
25	San Francisco River	BLM (Safford)	33-90251.0	Pending	Pending	10/21/1985
26	San Francisco River	Phelps Dodge Corporation	33-96759.0	Pending	Pending	6/3/2004
27	San Pedro River	BLM (Safford)	33-90103.1	90103	90103	8/12/1985
28	San Pedro River	BLM (Safford)	33-95780.0	Pending	Pending	1/8/1991
29	San Pedro River	BLM (Safford)	33-95789.0	Pending	Pending	4/1/1991
30	San Pedro River	BLM (Safford)	33-96126.1	Pending	Pending	8/6/1991
31	San Pedro River	BLM (Safford)	33-96127.1	Pending	Pending	8/6/1991
32	Spring Canyon Spring	BLM (Safford)	33-96799.0	Pending	Pending	6/13/2005
33	Wet Canyon	Coronado National Forest	33-96681.0	Pending	Pending	10/6/2000
34	Wildcat Canyon	BLM (Safford)	33-95454.0	95454	95454	6/6/1990

Source: ADWR, 2005b

Threatened and Endangered Species

A number of listed threatened and endangered species may be present in the Southeastern Arizona Planning Area. Those listed by the U.S. Fish and Wildlife Service (USFWS) as of May 2006 are shown in Table 3.0-2.[2] Presence of a listed species may be a critical consideration in water resource management and supply development in a particular area. The USFWS should be contacted for details regarding the Endangered Species Act (ESA), designated critical habitat and current listings.

Conservation Areas, Refuges and Preserves

The only two Riparian National Conservation Areas in the nation are found in the planning area the San Pedro Riparian National Conservation Area (SPRNCA) and the Gila Box Riparian National Conservation Area. The SPRNCA was established in November 1988 and contains about 40 miles of riparian area along the San Pedro River in the Upper San Pedro Basin. It includes over 58,000 acres of land between the international border with Mexico and the community of Saint David south of Benson. The primary purpose for the designation is to protect and enhance the desert riparian ecosystem (BLM, 2006a). The 22,000 acre Gila Box Riparian National Conservation Area was established in November 1990 with the principle objective to “conserve, protect, and enhance” the riparian and associated values of the area. The conservation area is located within the Bonita Creek, Duncan Valley, Morenci and Safford Basins. Four perennial waterways, the Gila

[2] An “endangered species” is defined by the USFWS as “an animal or plant species in danger of extinction throughout all or a significant portion of its range,” while a “threatened species” is “an animal or plant species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.”

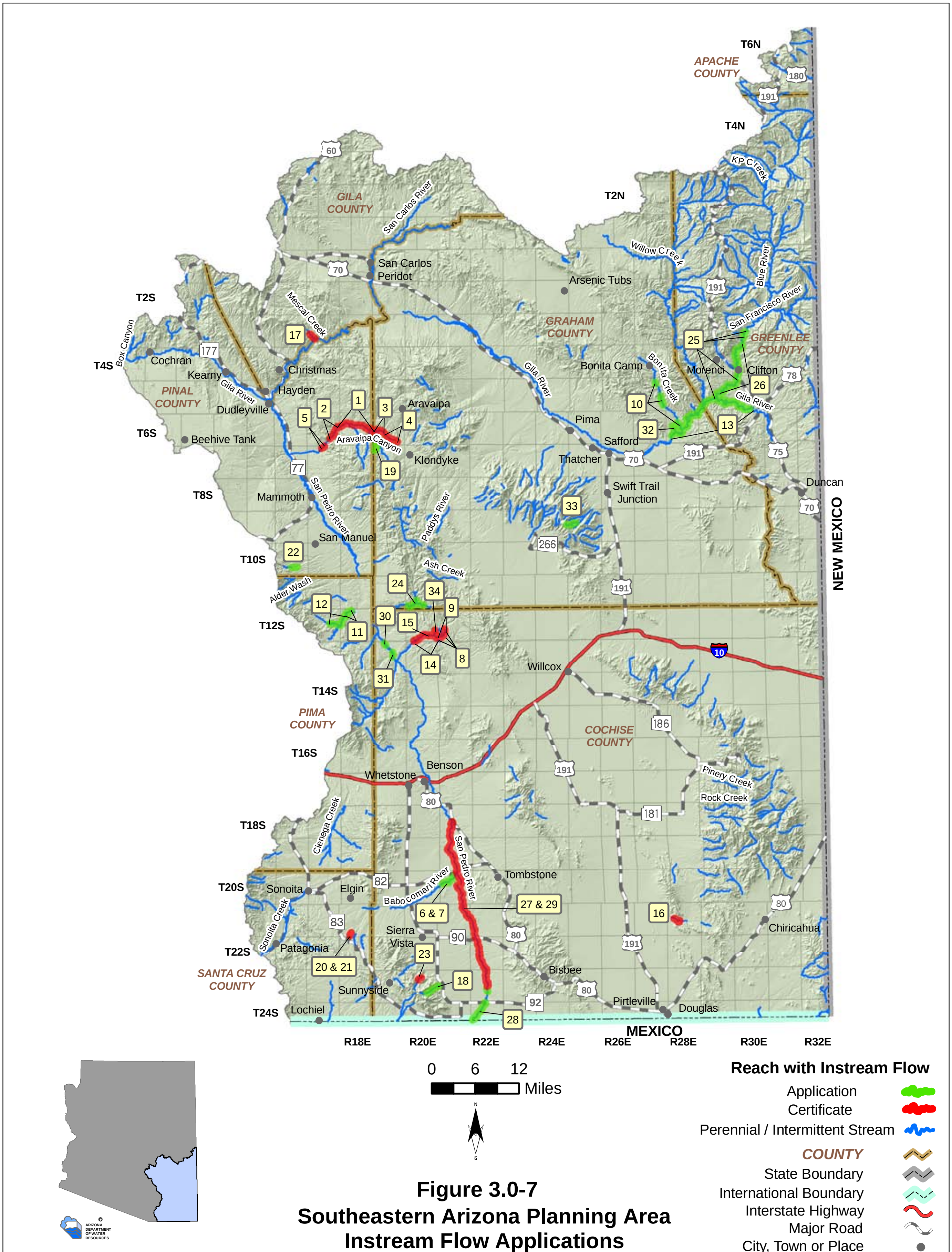


Figure 3.0-7
Southeastern Arizona Planning Area
Instream Flow Applications

Table 3.0-2 Listed threatened and endangered species in the Southeastern Arizona Planning Area

Common Name	Threatened	Endangered	Elevation/Habitat
Apache Trout	X		>5000 ft./cold mountain streams
Arizona Cliff-rose		X	<4,000 ft./white soils of tertiary limestone lake bed deposits
Arizona hedgehog cactus		X	3,700-5,200 ft./ecotone between interior chapparal and madrean evergreen woodland
Bald Eagle	X		Varies/large trees or cliffs near water
Beautiful shiner	X		<4,500 ft./small to medium sized streams and ponds
California Brown Pelican		X	Varies/lakes and rivers
Canelo Hills ladies'- tresses		X	5,000 ft./finely grained, highly organic, saturated soils of cienegas
Chiricahua Leopard Frog	X		3,300-8,900ft./streams, rivers, backwaters, ponds stock tanks
Cochise pincushion cactus	X		>4,200 ft./ semi-desert grassland with small shrubs, agave, cacti, grama grass
Desert pupfish		X	<5,000 ft./shallow springs, small streams and marshes. Tolerates saline and warm water
Gila Chub		X	2,000-5,500 ft./pools, springs, cienegas and streams
Gila topminnow		X	<4,500 ft./small streams, springs and cienegas vegetated shallows
Gila trout	X		5,000-10,000 ft./small, high mountain streams
Huachuca water umbel		X	3,500-6,500 ft./cienegas, perennial low gradient streams, wetlands
Jaguar		X	1,600->9,000 ft./Sonoran desertscrub through subalpine conifer forest
Lesser long-nosed bat		X	<6,000 ft./desert scrub with agave and columnar cacti
Loach Minnow	X		<8,000ft./benthic species of small to large perennial streams
Mexican Gray Wolf		X	4,000-12,000 ft. /chapparal, woodland, forests
Mexican Spotted Owl	X		4,100-9,000 ft./canyons, dense forests with multi-layered foliage structure
Mount Graham red squirrel		X	>8,000 ft./montane upper elevation mature to old-growth conifer forest

Common Name	Threatened	Endangered	Elevation/Habitat
New Mexico ridge-nosed rattlesnake	X		5,000-6,600 ft./canyon bottoms in pine-oak communities
Nichol's Turk's head cactus		X	2,400-4,100 ft./Sonoran desertscrub
Northern aplomado falcon		X	3,500-9,000 ft./grassland and savannah
Ocelot		X	<8,000 ft./humid tropical and sub-tropical forests, savannahs and semi-arid thornscrub
Pima pineapple cactus		X	2,300-5,000 ft./Sonoran desertscrub or semi-desert grassland
Razorback sucker		X	<6,000 ft./riverine and lacustrine areas, not in fast moving water
Sonora tiger salamander		X	4,000-6,300 ft./stock tanks and impounded cienegas
Southwestern Willow Flycatcher		X	<8,500 ft./cottonwood-willow and tamarisk along rivers and streams
Spikedace	X		<6,000 ft./moderate to large perennial streams with gravel cobble substrates
Yaqui catfish	X		4,000-5,000 ft./moderate to large streams with slow current
Yaqui chub		X	4,000-6,000 ft./deep pools of small streams or ponds near undercut banks
Yaqui topminnow		X	<4,500ft./small to moderate sized streams, springs, cienegas in shallows

Source: USFWS, 2006a

River, Bonita Creek, Eagle Creek, and San Francisco River are contained in the area. A 15-mile segment of Bonita Creek and 23 miles of the Gila River are included in the conservation area.

The Las Cienegas National Conservation Area was established in December 2000 and encompasses about 45,000 acres. Most of the conservation area is located between the Empire and Whetstone mountain ranges generally north of Sonoita within the Cienega Creek Basin. A small part of the conservation area extends into the Upper San Pedro Basin. The conservation area was designated in order to protect a number of natural resources including aquatic, wildlife, vegetative and riparian. Livestock grazing and recreation are allowed to continue in "appropriate" areas. Goals include protecting water quality and water quantity. (BLM, 2006c).

A notable wilderness area, Aravaipa Canyon Wilderness Area, is located in the Aravaipa Canyon Basin. Administered by the Bureau of Land Management, it was designated in 1984 and includes 19,700 acres along the 10-mile long central gorge of the canyon, which cuts through the northern end of the Galiuro Mountains. The Nature Conservancy's (TNC) Aravaipa Canyon Preserve, consisting of about 7,000 acres, includes lands at both the east and west ends of Aravaipa Canyon as well as lands on the canyon's south rim (TNC, 2006a).

There are two National Wildlife Refuges (NWR) in the planning area, the San Bernardino NWR in the San Bernardino Valley Basin and Leslie Canyon NWR located in the Douglas and Willcox Basins. Both refuges were established in the 1980s to protect water resources and habitat for endangered native fishes and rare velvet ash-cottonwood-black willow gallery forest. (USFWS, 2006b).

The Nature Conservancy has acquired a number of properties in the planning area for habitat protection, particularly in the Lower San Pedro Basin. In addition to the previously mentioned Aravaipa Canyon Preserve, TNC preserves include Buehman Canyon Preserve and the San Pedro River Preserve near Winkelman, all located in the Lower San Pedro Basin. Other TNC preserves include the Ramsey Canyon Preserve in the Huachuca Mountains in the Upper San Pedro Basin, and the Patagonia-Sonoita Creek Preserve in the Cienega Creek Basin. The Muleshoe Ranch Cooperative Management Area is a 49,000 acre preserve established to preserve native fish and grassland located in the Lower San Pedro, Upper San Pedro and Willcox Basins. This area is managed cooperatively by the TNC, BLM and USFS.

In addition to preserves, the TNC has acquired properties to establish conservation easements that retire irrigated agriculture and reduce groundwater pumping along the San Pedro River. These include the 2,150 acre Three Links Farm, located about 15 miles north of Benson in the Lower San Pedro Basin that contains more than six miles along the river, and a property near the San Pedro River Preserve. Other TNC-facilitated areas with conservation easements are the 18,500 acre San Rafael Ranch Natural Area in the San Rafael Basin and the 909 acre Sylvester Ranch in Palominas in the Upper San Pedro Basin. (TNC, 2006b)

Pima County has acquired two ranches in the Lower San Pedro Basin as part of the Sonoran Desert Conservation Plan the A-7 Ranch located in the northeast corner of Pima County and the northwest corner of Cochise County, and the Six-Bar Ranch located ten miles south of San Manuel west of the San Pedro River. These two conservation preserves total over 10,000 acres (Pima County, 2006). The County also owns the Bingham Cienega Preserve in the Lower San Pedro Basin where it is restoring riparian and grassland ecosystems.

In the Lower San Pedro Basin, the Salt River Project and the US Bureau of Reclamation (BOR) have acquired, or are proposing to acquire, lands for Southwestern Willow Flycatcher habitat along the San Pedro River. The BOR has also completed an Environmental Assessment as part of the acquisition of lands for Southwestern Willow Flycatcher habitat in the Safford Basin. (BOR, 2006)

The world-renowned Kartchner Caverns State Park is located southwest of Benson in the Whetstone Mountains. A wet cave, it is supported by a limestone aquifer that is recharged by infiltration from ephemeral washes. There is concern about the impact on this hydrologic system from impending development in the area.

3.0.5 Population

Census data for 2000 show about 186,600 residents in the Southeastern Arizona Planning Area. Arizona Department of Economic Security (DES) population projections forecast about 301,000 residents by 2050. Historic, current and projected population for each basin are listed in the cultural water demand tables. Projections may not accurately reflect the most recent proposed developments. For example, the current official DES projections for Benson do not include a large development, Whetstone Ranch, planned to include more than 18,000 housing units nor other proposed developments in the Benson/Whetstone area. A large-scale development has also been proposed near Safford that would include 5,100 to 7,100 homes and a 27-hole golf course and commercial area (Eastern Arizona Courier, 2005).

The most populous basins reported in the 2000 census are the Upper San Pedro (78,013), Safford (39,706), Douglas (26,218), Lower San Pedro (16,595), and Willcox (12,377) Basins. Six basins in the planning area are sparsely populated with populations of less than 200 including Aravaipa Canyon, Bonita Creek, Donnelly Wash, Dripping Springs Wash, San Bernardino Valley and San Rafael Basins. The 2000 Census population of the San Carlos Apache Reservation was 9,385, an increase of over 2,000 residents since the 1990 census.

Shown in Table 3.0-3 are incorporated and unincorporated communities in the planning area with 2000 Census populations greater than 1,000 and growth rates for two time periods. There are several rapidly growing communities including Sierra Vista and adjacent areas, Douglas, Whetstone and Swift Trail Junction south of Safford. The largest municipality in the planning area is Sierra Vista with a 2000 Census population of 37,775, or 20% of the planning area population. The population of the Sierra Vista subwatershed (roughly the southern half of the basin), contained about 37% of the planning area population in 2000. About half the population of the San Carlos Apache Reservation resides in Peridot and in the community of San Carlos (the 10th largest community in the planning area and the tribal headquarters). Some communities in the planning area, including Clifton, Kearny and Mammoth have lost population due to declines or closures of mining operations. Between 1990 and 2000, the population living in smaller communities and rural areas grew faster than the population living in communities with 1,000 or more residents. Communities are listed in Table 3.0-3 from highest to lowest population according to the most recent reported year (2000 or 2005).

Table 3.0-3 Communities in the Southeastern Arizona Planning Area with a 2000 Census population greater than 1,000

Communities	Basin	1990 Census Pop.	2000 Census Pop.	Percent Change 1990-2000	2005 Pop. Estimate	Percent Change 2000-2005	Projected 2050 Pop.
Sierra Vista	USP	32,983	37,775	14.5	43,690	15.7%	61,833
Sierra Vista SE	USP	9,237	14,348	55.3	NA	---	16,854
Douglas	DOU	13,137	14,312	8.9	17,195	20.1	17,974
Safford	SAF	7,359	9,232	25.5	9,360	1.4	18,776
Bisbee	USP/DOU	6,288	6,090	-3.1	6,570	7.9	6,875
Benson	USP	3,824	4,711	23.2	4,740	0.6	4,806
San Manuel	LSP	4,009	4,375	9.1	NA	---	5,102
Thatcher	SAF	3,763	4,022	6.9	4,550	13.1	7,273
Willcox	WIL	3,122	3,733	19.6	3,885	4.1	4,281
San Carlos	SAF	2,918	3,716	2.7	NA	---	4,220
Oracle[1]	LSP	3,043	3,563	17.1	NA	---	9,883
Clifton	MOR	2,840	2,596	-8.6	2,495	-3.9	4,101
Whetstone	USP	1,289	2,354	82.6	NA	---	2,548
Kearny	LSP	2,262	2,249	-0.6	2,185	-2.8	3,587
Swift Trail Jct.	SAF	1,203	2,195	82.5	NA	---	6,574
Pima	SAF	1,725	1,989	15.3	2,085	4.8	3,350
Morenci	MOR	1,799	1,879	4.4	NA	---	2,422
Huachuca City	USP	1,782	1,751	-1.7	1,830	4.5	2,633
Mammoth	LSP	1,845	1,762	-4.5	1,740	-1.2	2,312
St. David	USP	1,468	1,744	18.8	NA	---	2,928
Tombstone	USP	1,220	1,504	23.3	1,610	7.0	1,789
Dudleyville	LSP	1,356	1,323	-2.4	NA	---	2,769
Peridot	SAF	957	1,266	32.3	NA	---	3,192
Total >1,000		109,429	128,489	17.4	NA	---	196,082
Other		46,236	58,123	25.7	NA	---	104,874
Total		**155,665**	**186,612**	**19.9**	**NA**	**---**	**300,956**

Source: DES, 2005
Note: 2005 population estimates not available for unincorporated communities
[1] The community of Oracle is located in the Lower San Pedro Basin but its water supply comes from wells at Oracle Junction in the Tucson AMA.
USP=Upper San Pedro Basin; DOU=Douglas Basin; SAF=Safford Basin; WIL=Willcox Basin; LSP=Lower San Pedro Basin; MOR=Morenci Basin

Population Growth and Water Use

The state currently has limited mechanisms to address the connections between land use, population growth and water supply. A legislative attempt to link growth and water management planning is the Growing Smarter Plus Act of 2000 (Act) which requires that counties with a population greater than 125,000 (2000 Census) include planning for water resources in their comprehensive plans. None of the counties in the planning area fit this population criterion. However, Cochise County has incorporated water resource planning into its comprehensive plan, has adopted water use guidelines for certain area plans and is pursuing creation of an overlay district in the southern part of the Upper San Pedro Basin that would set water conservation standards for new developments. The Act also requires that twenty-three communities outside AMAs include a water resources element in their general plans. In the Southeastern Arizona Planning Area this includes the communities of Benson, Douglas, Safford and Sierra Vista. References to completed plans are listed in basin references in this volume and may contain useful information for water resource planning.

The Department's Water Adequacy Program also connects water supply and demand to growth to some extent but does not control growth. Developers of subdivisions outside of AMAs are required to obtain a determination of whether there is sufficient water of adequate quality available for 100 years. If the supply is inadequate, lots may still be sold, but the condition of the water supply must be disclosed in promotional materials and in sales documents. The service areas of the Cities of Benson, Douglas, Willcox, Safford and the Empirita Water Company have been designated as having an adequate water supply. If a subdivision is served by one of these water providers then a separate adequacy determination is not required. Basin adequacy determinations, including the reason for the inadequate determination, are provided in the basin sections of this volume and are summarized below.

Table 3.0-4 Water Adequacy Determinations in the Southeastern Arizona Planning Area as of 5/2005

Basin	Number of Subdivisions	Number of Lots	Adequate	Inadequate	Percent of Lots Inadequate
Aravaipa Canyon	none	none	none	none	none
Bonita Creek	none	none	none	none	none
Cienega Creek	12	441	289	152	34
Donnelly Wash	1	59	0	59	100
Douglas	6	415	65	350	84
Dripping Springs Wash	none	none	none	none	none
Duncan Valley	3	268	61	207	77
Lower San Pedro	11	UNK	145	UNK	UNK
Morenci	9	1,759	1,725	34	19
Safford	20	731	139	592	81
San Bernardino Valley	none	none	none	none	none
San Rafael	none	none	none	none	none
Upper San Pedro	185	22,508	18,266	4,242	19
Willcox	20	1,577	989	588	37
TOTAL	267	27,903	21,679	6,224	22

UNK = Unknown

3.0.6 Water Supply

Local aquifers are the primary water supply for the planning area for municipal, industrial and agricultural use. Only about 18% of the cultural water demand is served by surface water. Most of the surface water is for agricultural use, and includes diversion from the San Pedro River in the Lower San Pedro and Upper San Pedro Basins, from Aravaipa Creek in the Aravaipa Canyon Basin and from the Gila River for use in the Duncan Valley and Safford Basins. The Gila River diversions are substantial, accounting for 95% of all surface water diversions in the planning area. Small amounts of surface water are diverted for municipal use in the Morenci, Upper San Pedro and Willcox Basins and for industrial use in the Morenci Basin. Some communities utilize effluent for golf course irrigation and for groundwater recharge. Sites of environmental contamination may impact the availability of water supplies in some locations.

Legal availability of water supplies is an issues in the Southeastern Arizona Planning Area. The Arizona Water Rights Settlement Act of 2004 (P.L. 108-45) includes settlement of the Gila River Indian Community's water rights claims in Title II of the Act. This settlement affects the volume and utilization of groundwater and surface water upstream from the Community in parts of the planning area. (See ADWR, 2006).

Surface Water

Surface water is a municipal supply for the City of Tombstone in the Upper San Pedro Basin, for the town of Morenci in the Morenci Basin and Fort Grant in the Willcox Basin. The City of Safford uses water collected in an infiltration gallery along Bonita Creek but for the purposes of this report, the water is considered groundwater. The City of Tombstone began using surface water from springs in the Huachuca Mountains west of Tombstone in 1881 and currently diverts water from Miller and Carr Springs. This water is conveyed through a more than 25-mile, gravity fed, seven-inch diameter steel pipeline to Tombstone. Surface water is an industrial and municipal supply in the Morenci Basin at Morenci.

Surface water is diverted from several rivers in the planning area for agricultural irrigation. This supply may not always be available when needed. For example, surface water from the San Pedro River in the vicinity of Saint David is typically only available during the period from November to May. In addition to diversions from the San Pedro River in the Lower and Upper San Pedro Basins, there are small surface water diversions from Aravaipa Creek in the Aravaipa Canyon Basin, and larger diversions from the Gila River. Water diverted from the Gila River is delivered to agricultural lands in the Safford and Duncan Valley Basins. When sufficient surface water is not available, the shortfall is made up by additional groundwater withdrawals. This shortfall may be dramatic. For example, the percentage of surface water used in the Safford and Duncan Valley Basins in 2000 was 27% compared to 60% in 1999.

Phelps Dodge Corporation provides water to the Morenci Mine Complex and the town of Morenci in the Morenci Basin in part through complex exchange agreements involving several water sources, some of which are located outside the planning area. Currently, Phelps Dodge utilizes exchange credits from both Horseshoe Reservoir on the Verde River and the Central Arizona Project through lease agreements with the San Carlos Apache Tribe, to divert water from the Black River at the Black River Pump Station in the Upper Salt River Basin. This water is pumped over the watershed divide into Willow and Eagle Creeks where it is transported for about 51 miles before being commingled with water from Phelps Dodge's Upper Eagle Creek Well Field. Phelps Dodge also uses water from Eagle Creek, Chase Creek and the San Francisco River (ADWR, 2005c). Historically, Phelps Dodge also had water exchange agreements involving Show Low

Lake and Blue Ridge Reservoir in the Little Colorado River Basin. It relinquished its certificated rights to both water sources in 2005.

The location of surface water resources are shown on maps entitled “Surface Water Conditions” and “Perennial/Intermittent Streams and Major (>10 gpm) Springs” for each basin and in basin tables containing data on streamflow, flood ALERT equipment, reservoirs, stockponds and springs in the Water Resource Characteristics sections.

Groundwater

Major aquifers supplying groundwater are basin fill, sedimentary rock (Gila Conglomerate), volcanic rock and recent stream alluvium. Groundwater supplies about 82% of the water demand in the planning area.

Groundwater development in basins located in the north and northeastern part of the planning area (Bonita Creek, Dripping Springs Wash, Duncan Valley and Morenci) is primarily from wells that tap the younger basin fill or the Gila Formation. Basin fill is the major aquifer in all three sub-basins of the Safford Basin. In some areas of the Safford Basin the groundwater supply may contain high total dissolved solids (TDS) and fluoride, which may affect its suitability for use.

In basins located on the western side of the planning area (Aravaipa Canyon, Donnelly Wash, Lower and Upper San Pedro), groundwater is pumped from the stream alluvium and from basin-fill sediments. Most irrigation wells are located in the stream alluvium while most industrial and domestic wells are located in the regional basin fill. The recent stream alluvium is the main source of water in the Aravaipa Canyon Basin for all uses and water quality is good. There is very limited water development in the Donnelly Wash Basin. In the Upper San Pedro Basin, most of the water used is pumped from aquifers. Artesian conditions in some areas support modest groundwater discharges for irrigation use in the Benson-Pomerene area, though to a lesser extent, and historically in the Palominas-Hereford area. Groundwater quality is generally good although there are some areas of local contamination including nitrate contamination near St. David. In the Lower San Pedro Basin, most mining, industrial and domestic/municipal wells are located in the regional basin-fill aquifer while most irrigation wells are located in the stream alluvium. Water quality is generally suitable for most uses.

Groundwater conditions in the Cienega Creek Basin are somewhat complex as described in Section 3.0.2. Stream alluvium aquifers support stock and domestic uses in the northern part of the basin while basin fill is the principal aquifer in the central valley of the basin. In the southwestern section of the basin, the stream alluvium aquifer supplies almost all groundwater used in the area for irrigation, domestic and stock purposes. There are no serious water quality issues that affect the use of groundwater in the basin.

The principal source of groundwater for all purposes in the Willcox Basin is alluvial deposits. There has been heavy agricultural pumpage in some areas, resulting in changes in groundwater flow direction, supply depletion and possible land subsidence (USGS, 2006a).

The three basins with groundwater outflow to Mexico have differing groundwater supply conditions. In the San Bernardino Valley Basin, groundwater is obtained from thin units of sand and gravel interbedded with basalt flows or from shallow alluvium. Most wells in the basin are located immediately north of the international border where water levels are generally less than 100 feet below land surface. Artesian wells and springs support wetlands designated as the San Bernardino National Wildlife Refuge. The main aquifer in the Douglas Basin is basin fill, which supplies most of the large-capacity wells. In the City of Douglas area, groundwater is pumped from basin fill with interbedded volcanic rock. The basin has been severely over drafted since the late 1940s and much of the basin is designated as an Irrigation Non-Expansion Area to restrict agricultural expansion. Groundwater quality is generally suitable for most uses in the basin but high concentrations of fluoride occur locally, making some water marginal for domestic uses. There is very little groundwater development in the San Rafael Basin where ranching is the primary activity. Groundwater is obtained from stream alluvium and basin fill.

Information on major aquifers, well yields, estimated natural recharge, estimated water in storage, aquifer flow direction, and water level changes are found in groundwater data tables, groundwater conditions maps, hydrographs and well yield maps for each basin in the Water Resource Characteristics sections.

Effluent

Effluent is utilized as a water supply in the Lower San Pedro, Safford, Upper San Pedro, and Willcox basins for golf course irrigation, agricultural irrigation and groundwater recharge. About 3% of the water demand in the Upper San Pedro Basin is met by effluent. In 2002, about 800 acre-feet of effluent from the Sierra Vista, Fort Huachuca and Benson Wastewater Treatment Plants was delivered for golf course irrigation and almost 1,000 acre-feet of effluent was recharged to the aquifer at Fort Huachuca and at the Sierra Vista Recharge Facility.

Contamination Sites

Sites of environmental contamination may impact the availability of water supplies. An inventory of Department of Defense (DOD), Superfund (Environmental Protection Agency designated sites), Water Quality Assurance Revolving Fund (WQARF, state designated sites), Voluntary Remediation Program (VRP) and Leaking Underground Storage Tank (LUST) sites was conducted for the planning area.

Table 3.0-5 lists the DOD, Superfund, VRP and WQARF sites, the contaminant and affected media and the basin location of the site. In addition, there are 203 active Leaking Underground Storage Tank (LUST) sites in the planning area, most of which are located in the Safford Basin and the Upper San Pedro Basin. The location of all contamination sites is shown on Figure 3.0-8.

Table 3.0-5 Active contamination sites in the Southeastern Arizona Planning Area

SITE NAME	MEDIA AFFECTED AND CONTAMINANT	GROUNDWATER BASIN
Department of Defense (DOD) Sites		
Fort Huachuca	Groundwater and soil – leaking underground storage tanks and solid waste disposal	Upper San Pedro
Safford Military Range	Soil-lead	Safford
Federal National Priority List (Superfund Sites)		
Apache Powder	Groundwater-arsenic, fluoride, nitrate, perchlorate Surface water-dinitoglycerine (DNT) Soil – arsenic, barium, metals, nitrate, vanadium pentoxide, trinitroglycerin (TNT)	Upper San Pedro
Voluntary Remediation Sites		
Arizona Copper Co	Soil – metals and solvents	Morenci
Bisbee Smelter	Soil and groundwater – metals	Douglas
Clifton School – Phelps Dodge	Soil - smelter fallout metals	Morenci
Douglas Parcel 408-18-025C	Soil – arsenic and copper	Douglas
Firebird Fuel Spill	Soil - Benzene, Toluene, Ethyl Benzene, Xylene (BTEX)	Douglas
Jobbing Warehouse	Soil – arsenic, lead and copper	Douglas
Phelps Dodge American Avenue	Soil – metals	Douglas
Shannon Hills Smelter	Soil – mine tailings, arsenic and copper	Morenci
Union Pacific Railroad San Simon Depot	Bunker C fuel oil	Safford
WQARF Sites		
Klondyke Tailings	Groundwater, surface water and soil - metals	Aravaipa Canyon

Sources: ADEQ, 2006a; ADEQ 2006b

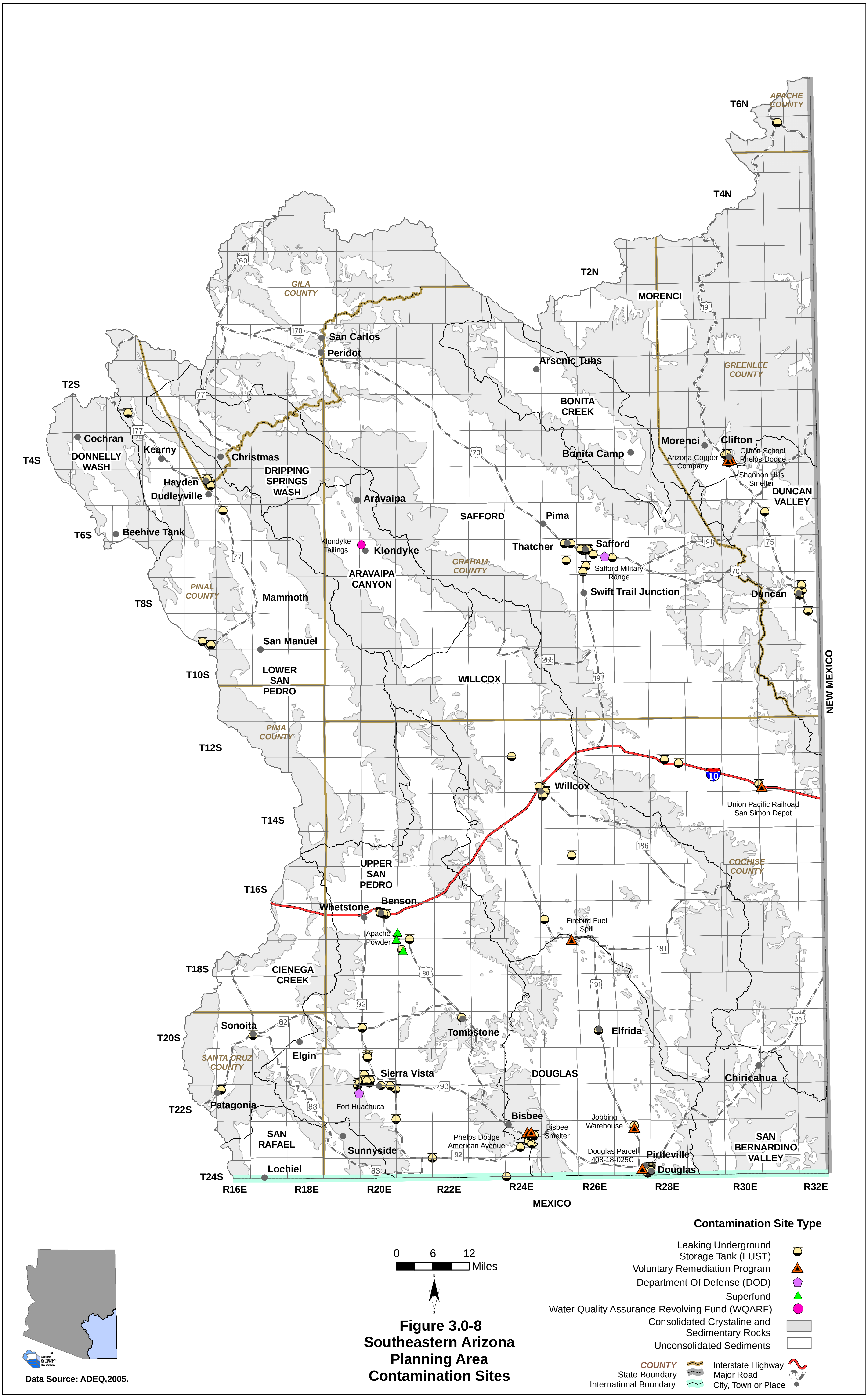


Figure 3.0-8
Southeastern Arizona Planning Area Contamination Sites

There are nine active VRP sites in the planning area. All sites in the Douglas and Morenci Basins are associated with mining-related activities. There are also three mining-related sites in the Morenci Basin. The only other site is a fuel oil contamination site at San Simon in the Safford Basin. The VRP is the state administered and funded voluntary cleanup program. Any site that has soil and/or groundwater contamination, provided that the site is not subject to an enforcement action by another remediation program, is eligible to participate. To encourage participation ADEQ provides an expedited process and a single point of contact for projects that involve more than one program. (Environmental Law Institute, 2002)

The Apache Powder Superfund site located about 2.5 miles southwest of Saint David in the Upper San Pedro Basin is the only Superfund site in the planning area. Apache Nitrogen Products (ANP) Inc., formerly known as Apache Powder Company, owns and operates a fertilizer and nitric acid manufacturing plant at the site. Soil, groundwater and surface water contamination has occurred due to past manufacturing and disposal practices at the site. Sampling has identified a nitrate plume affecting both groundwater and a short reach of the San Pedro River. Additional contaminants of concern include arsenic, fluoride, perchlorates and metals.

Cleanup efforts to date include removal of waste barrels and contaminated soils, and construction of a treatment wetland. A future cleanup schedule has been developed by ANP and remedial activities are being coordinated with the EPA and ADEQ (ADWR, 2005a).

DOD Installation Restoration Program funding has supported environmental cleanup of contaminated soils at Fort Huachuca in the Upper San Pedro Basin. Groundwater monitoring wells have been installed at the South Range Landfill and East Range Mine Shaft to monitor contamination. Groundwater contamination has not been identified. These sites are part of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) cleanup program. (ADWR, 2005a)

3.0.7 Cultural Water Demand

Total cultural water demand in the Southeastern Arizona Planning Area averaged approximately 550,000 acre-feet per year in the period from 2001-2003. The agricultural demand sector is by far the largest water demand sector with over 475,000 acre-feet of demand (see Figure 3.0-9). This is primarily due to agricultural demand in 4 basins Willcox, Safford, Duncan Valley and Douglas, which account for 443,500 acre-feet, or 93% of the agricultural demand. About one-fifth of the agricultural demand is met with surface water.

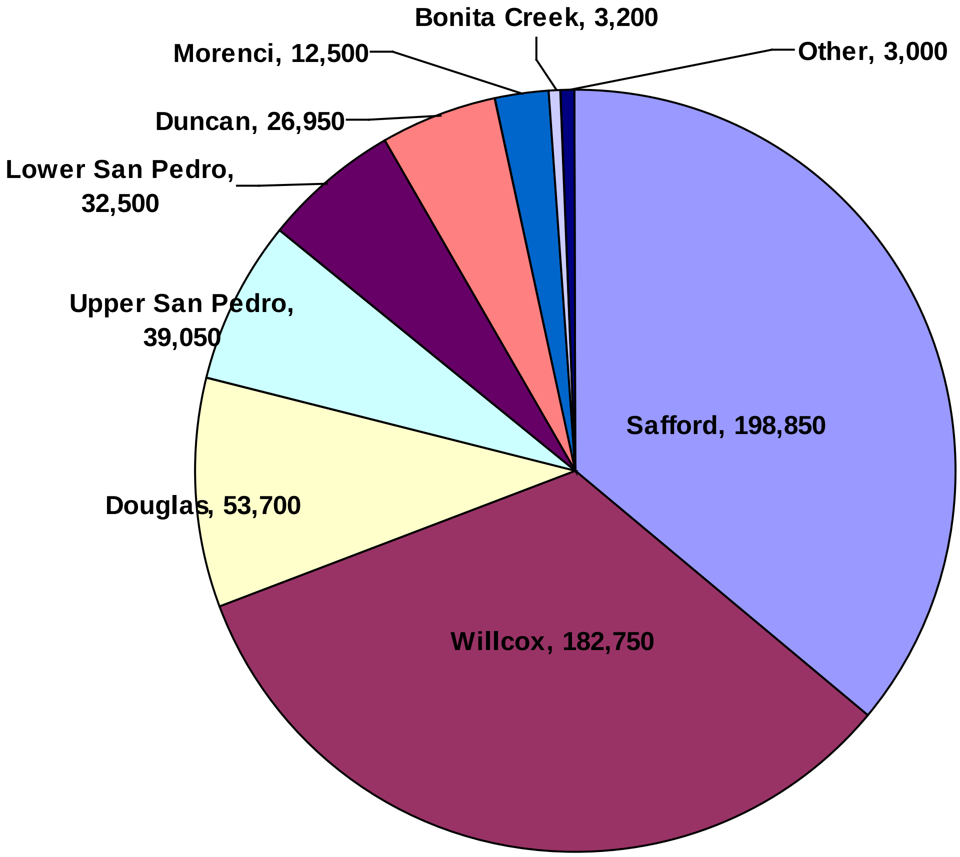
The volume of municipal water demand and industrial water demand is similar. Municipal demand was approximately 37,800 acre-feet of primarily groundwater demand per year in the period from 2001-2003. Only about 800 acre-feet of surface water was reported for municipal purposes. Industrial demand, primarily from mining, is about 33,700 acre-feet per year. Of this, about 500 acre-feet of surface water is used. The demand sector composition varies substantially from basin to basin as shown in the basin cultural demand tables. For example, there is no agricultural irrigation in six of the basins and total demand ranges from less than 300 acre-feet in several basins to almost 199,000 acre feet per year in the Safford Basin. (See Figure 3.0-10)

Detailed current information on San Carlos Apache Reservation water demand was not available to the Department. The reservation population is approximately 10,000, primarily residing in the communities of San Carlos/Peridot and Bylas/Calva. There is a golf course, hotel and casino complex (Apache Gold) west of the community of San Carlos. Principal economic activities on the reservation include cattle ranching, forestry, recreation, and gemstone mining (San Carlos Apache Nation, 2006). Farming has historically been important. Total cultural use in the Gila River drainage portion of the reservation was estimated at 4,120 acre-feet in a Bureau of Indian Affairs (BIA) report from the early 1970s (BIA, 1974). With the population increase since the BIA estimate and construction of the casino complex, and assuming that agricultural, livestock and industrial uses have remained constant, it is estimated that current demand is approximately 5,300 acre-feet per year.

Figure 3.0-9 Southeastern Arizona Planning Area average annual cultural water demand by sector, 2001-2003

Provisions of the Arizona Water Rights Settlement Act of 2004 have implications for water use in the planning area. Under Title II of the Act, Congress authorized a 2003 Settlement Agreement concerning the Gila River Indian Community's (GRIC) water rights. The 2003 Settlement Agreement was amended to conform to the Settlement Act and becomes enforceable on or before December 31, 2007. The Settlement Agreement established an Upper Gila River Watershed Maintenance Program that was incorporated into state law in 2005 (H.B. 2728). The program defines a Gila River Maintenance Area that covers much of the planning area except for the Willcox, Douglas and San Bernardino Valley Basins and portions of other basins in Cochise County. There are certain restrictions within the area, subject to specific exemptions, including construction of new dams or enlargement of existing dams and irrigation of land is prohibited unless the land was previously irrigated between January 1, 2000 and August 12, 2005. (ADWR, 2006)

Figure 3.0-10 Average total water demand by basin in acre-feet, 2001-2003



The settlement agreement also established "Safe Harbor" areas within which the Gila River Indian Community, the San Carlos Irrigation and Drainage District and the United States "agree not to exercise their rights to challenge, object to or call certain water users based on their normal flow rights and stored water rights under the Globe Equity Decree." (ADWR, 2006). The Safe Harbor provisions establish three Impact Zones with specific conditions for each. The impact zones are: 1) the San Pedro Ag and New Large Industrial Use Impact Zone, 2) the San Pedro M&I

and Domestic Purposes Impact Zone, and 3) the Gila River Impact Zone. These zones are in the proximity of the Gila and San Pedro Rivers and include named tributaries. For information on these provisions, refer to the Settlement Agreement and to the Technical Assessment of the Gila River Indian Community Water Rights Settlement (ADWR, 2006).

Municipal Demand

Primary municipal demand centers are the Sierra Vista area (including Bisbee), Douglas, Safford/ Thatcher, Benson, San Manuel and Willcox. Groundwater is the primary water supply for municipal use throughout the planning area. Municipal water demand in 2003 is summarized by groundwater basin in Table 3.0-6. Mining demand and municipal demand cannot be accurately distinguished in the Morenci area and groundwater and surface water supplies are commingled. As a result, the demand shown in Table 3.0-6 for the Morenci Basin is an estimate and all water used is assumed to be groundwater. There is little population or municipal demand in a number of basins in the planning area including Aravaipa Canyon, Bonita Creek, Cienega Creek, Donnelly Wash, Dripping Springs Wash, Duncan Valley, San Bernardino Valley and the San Rafael Basins. As shown, almost half of the municipal demand in the planning area is in the Upper San Pedro Basin. Municipal demand on the San Carlos Apache Reservation is assumed to be relatively small. Community water systems serve the San Carlos-Peridot community and Bylas-Calva, all in the Safford Basin (BIA, 1974). Based on population, a reasonable municipal demand estimate is 1,000 to 1,250 acre-feet per year.

Table 3.0-6 2003 municipal water demand in the Southeastern Arizona Planning Area

Basin	Groundwater (acre-feet)	Surface Water (acre-feet)	Effluent[1] (acre-feet)
Aravaipa Canyon	<300	0	0
Bonita Creek[3]	<300	0	0
Cienega Creek	600	0	0
Donnelly Wash	<300	0	0
Douglas	5,700	0	0
Dripping Springs Wash	<300	0	0
Duncan Valley	650	0	0
Lower San Pedro	2,000	0	NR
Morenci[2]	1,100	NR	0
Safford[3]	6,000	0	500
San Bernardino Valley	<300	0	0
San Rafael	<300	0	0
Upper San Pedro	18,000	<300	800
Willcox	2,700	<300	211
Total Municipal	37,500	<600	1,511

Sources: ADEQ, 2005a; ADWR, 2004; ADWR, 2005d; S. Tadayon, 2004; USGS, 2005

NR = Supply utilized but not reported

[1]Data on effluent demand is taken from effluent use for golf courses in 2005.

[2] Surface water and groundwater are commingled in this basin and cannot be distinguished.

[3] Shown on Table 3.0-6 is water utilized within the basin. The Cultural Demand Table for Bonita Creek in Section 3.2.8 reflects water withdrawn in the basin. Almost all of the approximately 3,200 acre-feet withdrawn in the Bonita Creek Basin is conveyed to the Safford Basin.

Only eleven water providers in the planning area served 450 acre-feet or more in 2003**.** These providers and their demand in 1991 and 2000 are shown in Table 3.0-7. Municipal gallon per capita per day (gpcd) rates are estimated to be about 125 gpcd in San Manuel, 157 gpcd in the Benson area, 168 gpcd in the Sierra Vista area, 177 gpcd in Safford, 225 gpcd in Douglas.

Table 3.0-7 Water providers serving 450 acre-feet or more of water per year, excluding effluent, in the Southeastern Arizona Planning Area

Basin/Water Provider	1991 (acre-feet)	2000 (acre-feet)	2003 (acre-feet)
Douglas			
Douglas Water Department	2,999	3,621	4,685
Lower San Pedro			
Arizona Water Company San Manuel	855	743	613[1]
Town of Kearny	483	648	489
Morenci			
Morenci Water and Electric	773	1,180	1,043
Safford			
City of Safford	3,748	3,836	4,006
Graham County Utilities, Inc - Pima	298	435	476
Upper San Pedro			
Arizona Water Company Bisbee	962	1,003	1,200
Arizona Water Company Sierra Vista	862	1,109	1,255
Bella Vista Water Company - Sierra Vista	2,907	3,208	3,640
City of Benson	545	728	912
Pueblo del Sol Water Company - Sierra Vista	360	1,136	1,470

Sources: ADWR 2005d; Upper Gila Watershed Partnership, 2005; WIFA, 2005; USGS, 2006c
[1] Data provided is water delivery for 2005

There are few municipally-owned water providers in the planning area. Municipal water utilities have more flexibility in setting water rates than private water companies, which are regulated by the Arizona Corporation Commission. In addition, municipal utilities have the authority to enact water conservation ordinances. These authorities enable municipal utilities to better manage water resources within water service areas. Water provider issues are discussed in section 3.0.8.

Provisions of the Settlement Agreement described above include individual agreements with the City of Safford and with the Towns of Duncan, Kearny, and Mammoth to resolve disputes regarding use of water for municipal and industrial purposes. These agreements set limits on future annual water use although actual use can exceed these limits under certain conditions and/or by implementing mitigation measures. (ADWR, 2006)

There are several golf courses in the planning area that are served from a municipal water supply. They are shown in Table 3.0-8 with estimated demand and source of water and are discussed below. Demand estimates account for elevation of the facility and duration of the irrigation season.

Table 3.0-8 Municipal golf course demand in the Southeastern Arizona Planning Area (c. 2004)

Facility	Basin	# of Holes	Demand (acre-feet)	Water Supply
Douglas Municipal Golf Course	Douglas	18	440	Groundwater
Hayden Golf Course	Lower San Pedro	9	211	Groundwater
Mt. Graham Golf Course	Safford	18	500	Effluent
Mountain View Golf Course	Upper San Pedro	18	370	Effluent
San Pedro Golf Course	Upper San Pedro	18	500	Effluent/Groundwater
Twin Lakes Municipal Golf Course	Willcox	9	211	Effluent

Source: ADWR, 2005e

Effluent is a municipal supply in a number of communities. As shown in Table 3.0-8, it is a supply for golf course irrigation in the Upper San Pedro, Safford and Willcox Basins. In the Upper San Pedro Basin, approximately 1,000 acre-feet of effluent were used in 2002 to irrigate three facilities: the Chaffee Parade Field (53 acre-feet) and Mountain View Golf Course at Fort Huachuca; and the San Pedro Golf Course at Benson. Effluent is recharged to the aquifer in constructed recharge facilities at Fort Huachuca and by the City of Sierra Vista. Between 2002 and 2005 a total of approximately 6,500 acre-feet of effluent was recharged at the Sierra Vista facility. Fort Huachuca recharges about 500 acre-feet of effluent per year. Plans are underway to transport and recharge 200 acre-feet/year of Huachuca City effluent at the Fort Huachuca recharge facility (ADWR, 2005a).

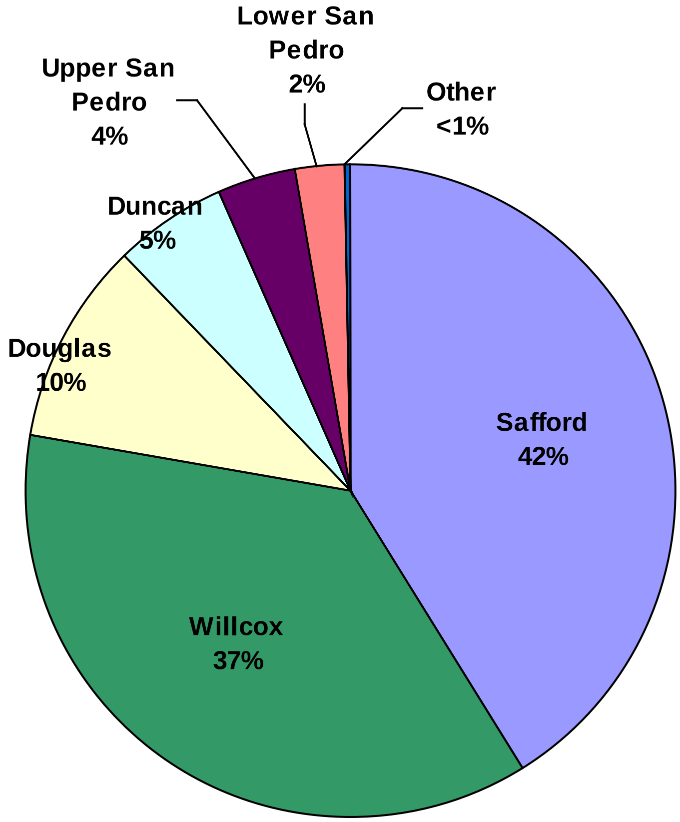
Effluent is used for irrigation at Kearny, Safford, Fort Grant, Thatcher and Bisbee. This irrigation is typically part of the effluent disposal method. There are two effluent treatment wetlands located in the Upper San Pedro Basin. The wetland at the Apache Nitrogen Products facility was constructed as part of the Superfund clean-up and the wetland at the Sierra Vista Treatment Plant is operated in conjunction with the recharge facility.

The three separate wastewater treatment facilities that serve the Bisbee population centers of Old Bisbee, Warren and San Jose are in the process of being combined into a single plant at San Jose. In addition, the Bisbee collection system will be improved to reduce leakage and a substantial number of residents on septic systems will be connected to the sewer system. Effluent from Old Bisbee (about 130,000 gpd) has historically been discharged to Mule Gulch in the Douglas Basin. Plans are to either deliver the treated effluent to an end user and/or recharge it (ADWR, 2005a). Estimates of effluent production are found in the Cultural Water Demand sections for each basin.

Agricultural Demand

Agriculture is a large water use sector and an important segment of the economy in the planning area, particularly in the Safford, Willcox, Douglas and Duncan Valley Basins (Figure 3.0-11). Relatively recent declines in irrigated acreage have occurred in some planning area basins, including the Upper San Pedro Basin due to the establishment of the SPRNCA, urbanization and economic factors, and in the Lower San Pedro Basin due to land conservation efforts. Some additional agricultural land reductions have occurred in both of these basins since 2003 that are not reflected in the cultural demand tables.

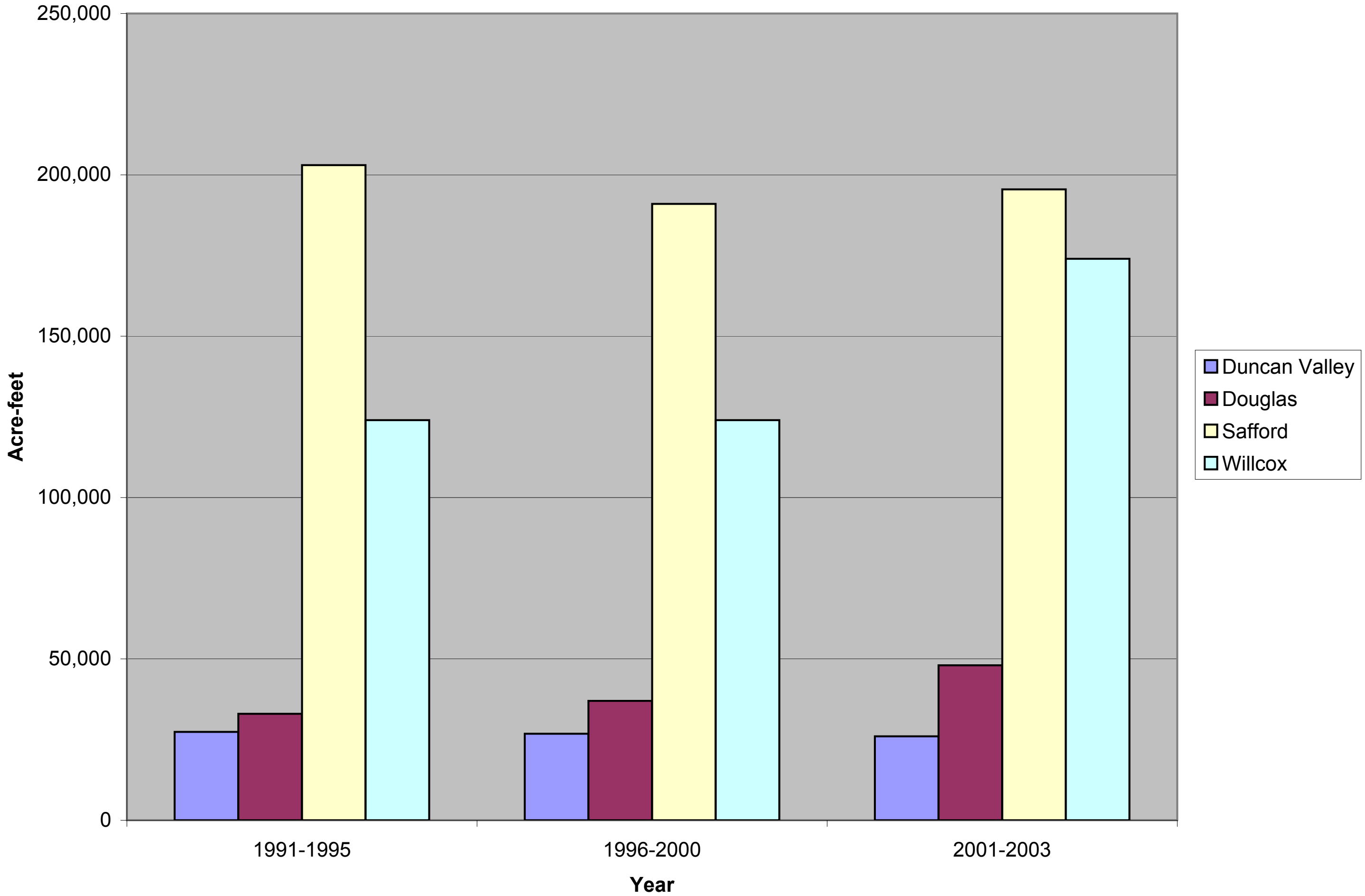
Figure 3.0-11 Average percentage of total agricultural demand in groundwater basins in the Southeastern Arizona Planning Area, 2001-2003



Source: USGS, 2005; ADWR, 2005f

Agricultural demand is stable or expanding in those basins with historically large agricultural demand (Figure 3.0-12). Although expansion of irrigated agricultural land is not permitted within the Douglas Irrigation Non-Expansion area (INA), demand increased on existing farmland to an average of about 48,000 acre-feet a year during the period 2001-2003 compared to an average of about 35,000 acre-feet per year from 1991-2000. In the Safford and Duncan Valley Basins, agricultural water demand has remained relatively stable since 1991, although the proportion of surface water available for use appears to have declined due to drought, leading to increased well pumpage in both basins. In the Willcox Basin, agricultural demand has declined significantly from the early 1970s when over 300,000 acre-feet per year was used. However, demand is now increasing with current annual demand averaging about 50,000 acre-feet over the average annual use from 1991-2000. A brief description of agricultural areas follows, listed generally in descending order of water demand.

Figure 3.0-12. Agricultural Demand in the Duncan Valley, Douglas, Safford and Willcox Basins, 1991-2003



Source: USGS, 2005; ADWR, 2005f

Safford and Duncan Valley Basins

In the Safford Basin, agricultural irrigation occurs along the Gila River where cotton and wheat are the predominant crops and in the San Simon Valley in the southern part of the basin where predominant crops include cotton, chile, alfalfa, corn and nut orchards. The Gila Valley Irrigation District (GVID), incorporated in 1923, encompasses about 35,500 acres along the Gila River from the San Carlos Apache Reservation boundary to about 12 miles east of Safford. There are ten canal companies within the GVID that deliver water to farmers who also irrigate using privately owned wells. Surface water use in the Safford area is pursuant to the Gila River Decree (Globe Equity No. 59 Decree) and when surface water is limited it is allocated to downstream users and not available for irrigation in the area. During the period of 2001-2003, an average of 122,500 acre-feet of groundwater and 73,000 acre-feet of surface water were used annually in the Safford Basin.

Duncan Valley Basin agricultural irrigation is located southeast of the Town of Duncan in the Duncan Valley and northwest of Duncan in the York Valley area. Principal crops include alfalfa, cotton, corn and wheat and there is some commercial vegetable production. The Franklin Irrigation District, also known as the Duncan Valley Irrigation District, serves farmers in the Duncan Valley. The district boundaries extend into New Mexico and irrigation wells in Arizona and New Mexico are used to irrigate lands in both states (Upper Gila Watershed Partnership, 2004). The District was formed in 1922 and encompasses about 4,700 acres of Gila River bottom land. Surface water rights for use within this district are also specified in the Gila River Decree (ADWR, 1998). In the Duncan Valley Basin, an average of 11,500 acre-feet of groundwater and 14,500 acre feet of surface water were used annually during the period 2001-2003.

Conditions of the GRIC Water Rights Settlement would affect agricultural water use in the Duncan Valley and Safford Basins. Several provisions of the Upper Valley Districts (UVD) Agreement affect upper valley irrigators in several basins (and including those in New Mexico) and could potentially impact flows in the Gila River (ADWR, 2006).

Willcox Basin

There is significant irrigation throughout the Sulphur Springs Valley in the Willcox Basin. North of the Town of Willcox are extensive orchards of apples and other fruits including U-pick orchards and vegetable farms. One of Arizona's few hydroponic tomato nurseries, Eurofresh Farms, a large, year-round producer of greenhouse tomatoes, is located in the northern part of the basin (Arizona Department of Agriculture, 2006). South of the Town of Willcox, irrigation is principally for alfalfa and corn. As in the Douglas Basin, groundwater withdrawals for agricultural irrigation in the Willcox Basin have resulted in large declines in groundwater levels and the formation of several large cones of depression. These groundwater level declines may have caused land subsidence and surface fissures south of the Town of Willcox (USGS, 2006a). Approximately 52,000 acres are currently irrigated, with about 174,000 acre-feet of groundwater demand per year.

Douglas Basin

Most of the Douglas Basin was designated as an INA in 1980 and as a result, agricultural irrigation is restricted to lands that were irrigated during the five-year period preceding designation. A requirement within an INA is that groundwater withdrawals for irrigation on more than ten acres must be measured and annually reported to the Department. These reports indicate that from 1984 to 2000, annual groundwater withdrawals fluctuated between about 30,000 acre-feet per year to about 45,000 acre-feet per year. However, as mentioned previously, demand is increasing with almost 55,000 acre-feet withdrawn in 2003. Irrigated acreage is located primarily in the central and northern part of the basin in the Sulfur Springs Valley. Currently, approximately 16,000 acres are being irrigated. Principal crops are alfalfa and corn. Center-pivot irrigation is the predominant irrigation method in the basin. Groundwater withdrawals for agricultural irrigation have resulted in significant declines in groundwater levels and a large cone of depression has formed in the northern part of the basin (USGS, 2006a).

Upper San Pedro Basin

In the Upper San Pedro Basin, almost all the remaining agriculture is in the Benson area. In 2002, there were an estimated 2,200 acres in the Benson area and 800 acres in the Palominas area under irrigation with a demand of about 14,500 acre-feet of groundwater and 4,300 acre feet of surface water. Reportedly in 2006, approximately 500 acres of irrigation in the Palominas area were taken out of production. There are two irrigation providers in the Benson area that deliver surface water from the San Pedro River: the Saint David Irrigation District (SDID) and the Pomerene Water Users Association (PWUA). Approximately 39% of the currently irrigated lands in the Benson area are served by one of these two districts. When insufficient surface water is available, SDID delivers groundwater pumped from two district wells. The PWUA does not operate groundwater wells to supplement the surface water supply although members use the canal system to deliver their own pumped water to their fields. Principal crops in the basin are alfalfa and pasture. (ADWR, 2005a)

Lower San Pedro Basin

Agricultural demand in the Lower San Pedro Basin averaged about 11,000 acre-feet a year during the period 2000-2003. Irrigated acreage is located along the San Pedro River throughout the length of the basin but primarily in the northern and southern portions of the basin. It is estimated that approximately 1,300 acres were irrigated in 2003 (USGS, 2005). Groundwater is the primary water supply for irrigation. Surface water diversions from the San Pedro River account for less than 1,000 acre-feet per year of the total water supply. Historically, principal crops have been pasture and small grains (ADWR, 1991).

Other Areas

There is currently limited vineyard irrigation in the Cienega Creek Basin in the Elgin area with some vineyard expansion planned. It is estimated that there were about 170 acres of vineyards in 2003 irrigated with groundwater. Water demand is estimated to be relatively low since vineyards are typically drip irrigated.

According to a CLIMAS report, several hundred acres of hay irrigation are occurring on the San Carlos Apache Reservation and the tribe has plans for expansion. Farming has been a culturally important activity and was economically important during the early years of the reservation (CLIMAS, 2004). According to a Bureau of Indian Affairs (BIA) study (1974), 1,900 acres were historically irrigated although flooding and inundation of lands by filling of the San Carlos Reservoir reduced the amount of irrigable acres. This study reported about 400-700 acres under irrigation, mostly alfalfa, hay and pasture, with a consumptive use of 3,500 acre-feet in the early 1970s. Most of the irrigable acreage was located along the San Carlos and Gila Rivers and was irrigated with surface water, supplemented with well water (Bookman-Edmonston Engineering, Inc., 1979).

Industrial Demand

Industrial water demand in the planning area includes mining, electrical power generation, dairies and feedlots, and golf course irrigation served by a facility water system. This demand is summarized in Table 3.0-9 for selected years.

Table 3.0-9 Industrial water demand in selected years in the Southeastern Arizona Planning Area

	1991	2000	2003
Type/Basin/Source	**Water Use (acre-feet)**		
Mining Total	**35,658**	**24,541**	**30,173**
Cienega Creek			
Groundwater	<300	<300	<300
Lower San Pedro			
Groundwater	18,000	4,800	18,500
Morenci			
Surface Water	1,782	1,004	1,085
Groundwater	14,500	18,000	10,000
Safford			
Groundwater	700	450	300
Upper San Pedro			
Groundwater	226	134	143
Willcox			
Groundwater	300	153	145
Power Plant Total	**6,600**	**6,000**	**6,100**
Willcox			
Groundwater	6,600	6,000	6,100
Golf Course Total	**1,808**	**1,908**	**2,258**
Duncan Valley			
Groundwater	211	211	211
Lower San Pedro			
Groundwater	422	422	422
Morenci			
Groundwater	75	75	75
Upper San Pedro			
Groundwater	1,100	1,200	1,550
Dairy/Feedlot Total	**251**	**264**	**848**
Duncan Valley			
Groundwater	92	92	92
Upper San Pedro			
Groundwater	42	42	42
Willcox			
Groundwater	117	130	714

Sources: USGS 2005; ADWR 2005c; ADEQ 2005b; ADWR, 2005e

Mining is the largest industrial user in the planning area, primarily due to activities in the Lower San Pedro and Morenci Basins. Major mining activities are discussed below.

The Morenci Mine in the Morenci Basin is North America's largest producer of copper and one of the largest open pit mines in the world. The mine property covers about 60,000 acres and includes five pits, three of which are currently in operation, and SX/EW (solution extraction/electrowinning) facilities. Reportedly, almost all of the water used at Morenci is recycled, some of it many times (Info Mine, 2006). Most of the water utilized by the mine and by the Morenci Water & Electric Company (a subsidiary of Phelps Dodge) is diverted from the Black River in the Salt River Basin and transported into the basin, or is from the Upper Eagle Creek Well Field. Water diverted from Gila River tributaries typically accounts for about 10% of the total (ADWR, 2005c). Phelps Dodge has a 50-year lease agreement with the San Carlos Apache Tribe pursuant to the San Carlos Apache Tribe Water Rights Settlement Act of 1992, as amended in 1997, to lease up to 14,000 acre-feet per year of its allocation of CAP water by means of an exchange at the Black River. Under the 1944 Horseshoe Exchange Agreement, Phelps Dodge also is entitled to diversions of up to 250,000 acre-feet from the Black River. As of 2003, Phelps Dodge had used almost 102,500 acre-feet of Horseshoe Reservoir credits (ADWR, 2005c). Water from recovery wells installed in the mine area for dewatering purposes is also used at the mine, as is effluent from the Morenci Water & Electric Company.

In the Lower San Pedro Basin, the ASARCO Ray Complex includes a 250,000 ton/day open pit mine northwest of Kearney, a SX/EW operation and a smelter at Hayden.

There are two large copper mines in the planning area that are currently out of production. The BHP Billiton Base Metals in-situ copper leaching operations at San Manuel in the Lower San Pedro Basin closed in early 2002 and underground mining at the site ceased in August 1999. In February 2002, Pima County approved BHP's request to redesignate some of its property for uses other than mining. It is unknown to the Department at this time if any mining operations will resume in the future at this site. (ADWR, 2006)

The Phelps Dodge Copper Queen mine in the Upper San Pedro and Douglas Basins currently consists of a small dump leaching and precipitation operation at the Lavender pit (Arizona Mining Association, 2006). Open pit mining started in 1917 and continued, with some interruptions, at the Sacramento pit and Lavender pit until 1974. All active mining stopped in 1984. Considerable dewatering of the mine workings was necessary with long-term groundwater production of about 4,000 acre-feet/year (Southwest Ground-water Consultants, Inc., 2004).

Phelps Dodge is developing a large open pit mining operation in the Safford Basin eight miles north of the town of Safford. The 3,400 acre Dos Pobres and San Juan operation is expected to be completed in 2008 and will include two open pits, one heap leach pad, one process solution pond, one evaporation pond, a SX/EW process plant and other infrastructure and support facilities (ADEQ, 2006c) Average annual groundwater demand by the mine is projected to be about 5,500 acre-feet per year (ADWR, 2006).

The only power plant in the planning area is the Arizona Electric Power Cooperative (AEPCO) Apache Station Generation Plant located in the Willcox Basin in Cochise, near Willcox. The plant is a gas-fired combined cycle plant built in 1963 that generates 520 megawatts of electric energy for its cooperative members, which are located throughout Arizona and California (AEPCO, 2006). Groundwater demand in 2003 was similar to that in 1991 but demand can vary annually, from a low of 4,100 acre-feet in 1996 to a high of 6,600 acre-feet in 1991.

There are seven industrial golf courses in the planning area defined as those courses with their own facility water supply. They are shown in Table 3.0-10 with estimated demand and source of water.

Demand estimates account for the elevation of the facility and duration of the irrigation season.

Table 3.0-10 Industrial golf course demand in the Southeastern Arizona Planning Area (c. 2004)

Facility	Basin	# of Holes	Demand (acre-feet)	Water Supply
Alpine Country Club	Morenci	18	75	Groundwater
Greenlee Country Club	Duncan	9	211	Groundwater
Kearny Golf Course	Lower San Pedro	9	211	Groundwater
Pueblo del Sol Country Club (Sierra Vista)	Upper San Pedro	18	475	Groundwater
San Manuel Golf Club	Lower San Pedro	9	211	Groundwater
Turquoise Hills Country Club (Benson)	Upper San Pedro	18	475	Groundwater
Turquoise Valley Country Club (Naco)	Upper San Pedro	18	500	Groundwater

Source: ADWR 2005e

There is also a golf course on the San Carlos Apache Reservation, the Apache Stronghold Golf Club, located near the Junction of Highway 77 and 170 in the Safford Basin. The water supply for this course is groundwater and effluent with an estimated use of 423 acre-feet, but it is not known if the service is from a municipal provider or from an industrial well.

Only two dairies have been identified in the planning area. There is a small, approximately 350 animal dairy north of Benson in the Upper San Pedro Basin and a new, large dairy of about 5,000 animals near Kansas Settlement in the Willcox Basin. Demand is about 42 acre-feet and 588 acre-feet respectively. There are also two feedlots in the Willcox Basin with a combined total of about 4,000 animals and a demand of about 130 acre-feet in 2004. Development of dairies and feedlots typically results in increased agricultural irrigation for feed.

The Apache Nitrogen Products facility is an ammonium nitrate manufacturing plant located south of Benson in the Upper San Pedro Basin. The facility has made efforts to reduce its water consumption, and in 2000 used 289 acre-feet of groundwater, a reduction of about 250 acre-feet since 1991.

There are a number of sand and gravel facilities located throughout the planning area. Some of these are identified on the cultural demand maps for each basin. However, not all are identified in the source data used for the maps. Water is used for aggregate washing, dust control, vehicle washing and equipment cooling. Typically, there is relatively little water consumed at these sites since most facilities recycle wash water. The Department estimated that a typical sand and gravel facility in the Upper San Pedro Basin uses less than 50 acre-feet per year (ADWR, 2005a).

3.0.8 Water Resource Issues in the Southeastern Arizona Planning Area

Population growth and associated concerns about sustainable water supplies, water level declines, increased agricultural demand and environmental protection activities have resulted in groundwater studies, regional planning activities, establishment of conservation easements and other activities in the planning area.

Water resource issues have been identified in the Southeastern Arizona Planning Area by community watershed groups, through the distribution of surveys, and from other sources. Primary issues identified are the lack of sufficient data to make informed water management decisions, legal issues related to surface water availability and the legal nature of water supplies, endangered species act implications, and concerns about whether there will be sufficient water supplies to meet future demand. A number of water systems reported concerns about aging infrastructure and the lack of financial resources to make capital improvements.

Watershed Groups

Several watershed groups have formed in the planning area to address water resource issues. Groups currently active within the planning area are the Middle San Pedro Partnership, the Eagle Creek Partnership, the Upper Gila Watershed Partnership, the Lower San Pedro Watershed Partnership-Redington NRCD, and the Upper San Pedro Partnership. A complete description of participants, activities and issues is found in Appendix B. Primary issues identified by these groups are summarized as follows:

Growth:
- Excessive growth in some areas
- Unregulated lot splits
- Desire to maintain rural setting, including agriculture, at current levels in Gila Valley

Water Supplies and Demand:
- Limited groundwater data
- Pumping impacts by Mexico on the San Pedro River and downstream users

Legal:
- Unresolved Indian water rights settlements
- Unresolved surface water adjudication
- Potential impact of adjudication court subflow definition
- Interbasin transfer prohibition

Water Quality:
- Poor quality groundwater and surface water in some areas
- Ability to meet new arsenic standard
- Concern about Superfund site and poor quality groundwater conditions

Environmental:
- Endangered Species Act (ESA) issues, critical habitat designation and mitigation efforts
- Impact of invasive species (Tamarisk) on surface water supply
- Lawsuits from environmental groups
- Potential impacts on riparian areas by continuation of current pumping

Funding:
- Limited funding resources for planning, projects, infrastructure and studies
- Extremely high cost of water augmentation projects

Drought:
- Drought impacts on surface water supplies, agriculture and cattle ranching

Other:
- Different perceptions of issues and goals in Benson community
- Difficulty in getting principle players to the table to discuss water
- Several high hazard unsafe dams in Gila Valley area
- Regular flooding in the Duncan-Virden area
- Opposition to government assistance to obtain groundwater information
- Potential loss of Fort Huachuca due to water/ESA issues
- Federal mandate to achieve sustainability by 2011 in the Sierra Vista subwatershed
- Political obstacles to potential water augmentation projects

Two of the partnerships in the planning area, the Upper Gila Watershed Partnership in the Safford Basin and the Upper San Pedro Partnership (USPP) in the Upper San Pedro Basin, have been organized for a number of years and have completed many projects. The Upper Gila Watershed Partnership initiated a Fluvial Geomorphology Study of the Upper Gila River that was funded through the Department's Water Protection Fund Program (98-054WPF), Graham County and the Bureau of Reclamation. The study area was of the Gila River from the boundary of the San Carlos Apache Reservation to the New Mexico Border. Its purpose was to demonstrate ways to manage the river, taking into account the geomorphic processes that dominate the fluvial systems (BOR, 2004). It also produced a study on current and projected water demand for the watershed. Both studies are posted on the Department's website.

A number of water management practices have been implemented in the Sierra Vista subwatershed portion of the Upper San Pedro Basin and additional ones are planned. These include groundwater recharge, direct effluent use, water conservation ordinances and municipal conservation programs. The USPP annually adopts and updates a water management and conservation plan for the Sierra Vista portion of the Basin. In addition, beginning in 2004, the Partnership must annually prepare a report (referred to as the '321 Report') on water use management and conservation measures that have been implemented and are needed to restore and maintain the sustainable yield of the regional aquifer by September 30, 2011 (Public Law 108-136).

The USPP and its members have initiated many conservation programs in the Sierra Vista area including the Water Wise program, a toilet rebate program and water conservation ordinances. Fort Huachuca, a partnership member, has implemented aggressive conservation efforts at the Fort that have reduced on-post water consumption by almost 45% since 1993. Cochise County has created a Water Conservation Office and requires comprehensive water conservation measures that apply when permitted land uses are intensified through rezonings, special uses and master development plans. It is pursuing adoption of an overlay district allowing these measures to also apply to permitted uses (Cochise County, 2006). The USPP is also evaluating water augmentation options including evaluating the costs and feasibility of constructing a pipeline to transport Central Arizona Project Water to the area.

Because the Upper San Pedro groundwater basin extends into Mexico, the Partnership is interested in promoting research and cooperative efforts with Mexico. Conservation efforts in the Mexican portion of the basin have been underway, including establishment of the Ajos-Bavispe National Forest and Wildlife Refuge and a 10,000 acre private reserve in the watershed (Sierra Vista Herald, 2006). (See the Upper San Pedro Partnership website for more information at www.usppartnership.com.)

In response to concerns of water planners, local citizens and environmental groups about the impacts of groundwater development, the Department, in collaboration with the USGS and funding from local partners, began conducting hydrogeologic investigations in 2005 to improve the understanding of water resources in two areas within the planning area: 1) the middle San Pedro Basin, which includes the Benson subwatershed and a portion of the Lower San Pedro Basin and 2) the Willcox and Douglas Basins. These investigations will assess the existing data collection networks and examine the current state of knowledge of the groundwater system, quantify the water budget for the area, including total water in storage, and establish a hydrologic monitoring network for on-going assessment of the aquifer. The San Pedro investigation is expected to take seven years and will result in a groundwater flow model. The Willcox/Douglas investigations are scheduled for three years and include establishment of a monitoring network for each basin, an inventory of agricultural groundwater pumpage in each basin, and a preliminary assessment of subsidence in the Willcox Basin (USGS, 2006a).

Issue Surveys

The Department conducted a rural water resources survey in 2003 to compile information for the public and help identify the needs of growing communities. This survey was also intended to gather information on drought impacts for incorporation into the Arizona Drought Preparedness Plan, adopted in 2004. Questionnaires were sent to almost 600 water providers, jurisdictions, counties and tribes. A report of the findings from the survey was completed in 2004 by the Department.

There were 29 water provider and jurisdiction respondents in the Southeastern Arizona Planning Area, and 14 numerically ranked issues. Respondents were asked to rank eighteen issues, which can be compressed into three categories: infrastructure, water supply and water quality. Infrastructure issues, which include storage and well capacity problems, were ranked among the top five issues by a majority of respondents. Water supply concerns also ranked relatively high, primarily due to concerns about adequate future supplies. In addition, about half of respondents noted at least one drought impact. Primary drought impacts noted were increased demand, increased peak demand and lowered groundwater levels.

Table 3.0-11 Water resource issues ranked by 2003 survey respondents in the Southeastern Arizona Planning Area (12 water providers and 2 jurisdictions)

Issue	Ranked as one of the top 5 issues (of 18)	Percent of respondents
Inadequate well capacity to meet peak demand	7	50
Inadequate water supplies to meet future demand	4	29
Infrastructure in need of replacement	5	36
Inadequate capital to pay for infrastructure improvements	6	43

Source: ADWR, 2004

The Department conducted another, more concise survey of water providers in 2004. This was done to supplement the information gathered in the previous year in support of developing the Arizona Water Atlas, and to reach a wider audience by directly contacting each water provider. Through this effort, 55 water providers in the Southeastern Arizona Planning Area, with a total of approximately 46,900 service connections, were willing to participate and provide information on water supply, demand, infrastructure and to rank a list of seven issues.

In regard to the question of groundwater level trends in their service area, the 47 respondents reported as follows: 29 stable; 13 falling, 4 don't know, 1 variable. One water provider reported rising water levels. Responses are shown for those basins with respondents in Table 3.0-12.

Table 3.0-12 Groundwater level trends reported by 2004 survey respondents by groundwater basin (47 respondents)

Basin	Stable	Falling	Rising	Variable	Unknown
Aravaipa Canyon	1				
Cienega Creek	2				1
Douglas	2	2			
Duncan	1	2			1
Lower San Pedro	2			1	1
Morenci	1				
Safford	3	2			
Upper San Pedro	15	6	1		1
Willcox	2				

Source: ADWR, 2005h

Water providers were asked to rank issues from 0 to 4 with 0 = no concern, 1 = minor concern, 2 = moderate concern and 3 = major concern. Of the 55 water providers that responded to the survey, 44 ranked issues. These respondents include many of the largest water providers in the planning area including Bella Vista Water Company (Sierra Vista), City of Benson, City of Douglas, Gila Resources/Safford, Town of Kearny, Pueblo del Sol Water Company (Sierra Vista) and the City of Willcox.

Although responses to the 2003 questionnaire are not directly comparable to the 2004 survey due to differences in the form and wording of the surveys, responses to issues are similar as shown in Table 3.0-13. Responses indicate that inadequate capital for infrastructure improvements is an overwhelming concern in the planning area. Other infrastructure issues and drought also ranked high.

Table 3.0-13 Water resource issues ranked by 2004 survey respondents in the Southeastern Arizona Planning Area (44 water providers)

Issue	Moderate concern	Major concern	Total	Percent of respondents reporting issue was a moderate or major concern
Inadequate storage capacity to meet peak demand	8	7	15	34
Inadequate well capacity to meet peak demand	6	5	11	25
Inadequate water supplies to meet current demand	5	4	9	20
Inadequate water supplies to meet future demand	5	9	14	32
Infrastructure in need of replacement	9	9	18	41
Inadequate capital to pay for infrastructure improvements	4	23	27	61
Drought related water supply problems	9	8	17	39

Source: ADWR, 2005h

Issue response from several basins was limited as shown in Table 3.0-14. However, drought, inadequate water supplies for future demand, infrastructure in need of repair and inadequate capital for infrastructure improvements, were listed as a major or moderate concern in almost all basins.

Table 3.0-14 Number of 2004 survey respondents, by groundwater basin, that ranked the survey water resource issues a moderate or major concern (44 water providers)

Issue	ARA	CCK	DOU	DUN	LSP	MOR	SAF	USP	WIL
Inadequate storage capacity to meet peak demand			2	1		1	3	8	
Inadequate well capacity to meet peak demand			2		1		3	4	1
Inadequate water supplies to meet current demand			1		1		2	4	1
Inadequate water supplies to meet future demand	1		1	1	1	1	3	5	1
Infrastructure in need of replacement			3	1	1	1	2	8	2
Inadequate capital to pay for infrastructure improvements	1		4	2	1		4	14	1
Drought related water supply problems	1	1	2	2	1	1	4	4	1
Total number of respondents	1	1	4	3	1	2	6	24	2

Source: ADWR, 2005h
ARA = Aravaipa Canyon Basin
CCK = Cienega Creek Basin
DOU = Douglas Valley Basin
DUN = Duncan Basin
LSP = Lower San Pedro Basin
MOR = Morenci Basin
SAF = Safford Basin
USP = Upper San Pedro Basin
WIL = Willcox Basin

3.0.9 Groundwater Basin Water Resource Characteristics

Sections 3.1 through 3.14 that follow present data and maps on water resource characteristics of the fourteen groundwater basins in the Southeastern Arizona Planning Area. A description of the data sources and methods used to derive this information is found in Section 1.3 of Volume 1 of the Atlas. This section briefly describes general information that applies to all of the basins and the purpose of the information. This information is organized in the order in which the characteristics are discussed in Sections 3.1 through 3.14.

<u>Geographic Features</u>
Geographic feature maps are included to provide general orientation and show principal land features, roads, counties and cities, towns and places in the groundwater basin.

Land Ownership

The distribution and type of land ownership in a basin has implications for land and water use. Large amounts of private land typically translate into opportunities for land development and associated water demand, whereas public lands are typically maintained for a specific purpose or multi-use with little associated water use. State owned land may be sold or traded, and is often leased for grazing and farming. State legislation set aside specific sections in each township to be held in trust by the state for educational purposes, and other specified purposes, which are identified for each basin (Arizona State Land Department, 2006).

Climate

Climate data including temperature, rainfall and snowfall, and evaporation rates are critical factors in the hydrologic cycle and in water resource planning and management. Annual averages and variability, seasonality, and long-term trends are presented for each basin, as available, and may be useful in evaluating cultural water demands and supplies.

Surface Water Conditions

Depending on physical and legal availability, surface water may be an important water supply in some basins. Streamflow, flood gage, reservoir, stockpond and runoff contour data are presented for each basin, as available, and provide information on the physical availability of this supply. Seasonal and annual streamflows are an indication of the potential volume of surface water available for use. Stream gage stations are included in the basin tables if there is at least one year of record and annual streamflow statistics are included only if there are at least three years of record. Flood gage information is presented to direct the reader to areas where flooding has been or may be a problem. Large reservoir storage information includes data on the amount of surface water stored in large reservoirs, its uses and ownership. The number and capacity of small reservoirs is also provided as well as the number of stockponds in each basin. The number of stockponds is a general indicator of small-scale surface water capture and livestock demand. Runoff contours reflect the average annual runoff that can be expected in tributary streams over a particular area.

Perennial and Intermittent Streams and Major Springs

A map showing the approximate location of perennial and intermittent streams is provided for each basin. For some basins, more than one source of information was used. Due to recent drought, stream designations may or may not reflect current flow conditions. Also shown on the map and listed in tables is information on the springs in each basin. Some of the springs and perennial and intermittent stream reaches provide a water supply for municipal, industrial and agricultural purposes. Springs provide important habitat for wildlife, plants and invertebrates and therefore are of interest to the environmental community.

Groundwater Conditions

Groundwater is an important water supply for much of Arizona. Several indicators of groundwater conditions are presented for each basin.

- Major aquifer type(s) can be a general indicator of aquifer storage and productivity. Basin fill and alluvial aquifers generally have greater water in storage and produce more water to wells than consolidated rock (bedrock) aquifers .

- Well yields are a general indication of aquifer productivity. Information for large diameter wells is provided since it is assumed that their reported pump capacities are indicative of the aquifer's potential to yield water to a well. However, many factors can affect well yields including well design, pump size and condition and the age of the well.
- Natural aquifer recharge is a component of a basin's water budget that is difficult to quantify and is often estimated based on regional studies. This parameter is important in evaluating the safe and sustainable yields of an aquifer system.
- Aquifer storage is an estimate of the amount of water stored in an aquifer that may be available for future development and use.
- Groundwater level data show the depth to water in measured wells and changes in groundwater levels over time (hydrographs). Depth to water measurements are shown on mapped wells if there was a measurement taken during 2003-2004. Depths to water are an indication of how deep wells must be drilled in an area and potential costs to install and operate pumps. Hydrographs show the variability in groundwater depths at selected well sites and provide an indication of trends over time.
- Groundwater flow directions reflect the regional and long-term direction(s) of aquifer flow in a basin that may reflect important areas of aquifer recharge and discharge. Local and temporary flow conditions, as may be caused by pumping, are generally not shown, however flow directions in some basins indicate how localized pumping has altered regional flow patterns.

Water Quality

Surface and groundwater quality data were compiled from a variety of sources as described in Volume 1 Section 1.3. The data presented for each basin are an indication of areas where water quality exceedences have occurred and may affect current and future supplies. Additional areas of concern may exist where water quality samples have not been collected or sample results were not reviewed by the Department (e.g. samples collected in conjunction with ADEQ Aquifer Protection Permit Programs). It is important to note also that the exceedences shown may or may not reflect current surface and groundwater quality conditions or the quality of water currently used in the basin.

Cultural Water Demand

Cultural water demand can be an important component of a basin's water budget and may include well pumpage and/or surface water diversions for municipal, industrial and agricultural (irrigation) uses. Listed in a table for each basin are average annual water demands for the period 1971 through 2003 and the number of new water supply wells drilled over this period. Also listed in the tables are population estimates and projections for the basin. Without mandatory metering and reporting of water uses, accurate demand data were not available for all basins or for all years, and uses were often estimated. Annual water demand estimates were averaged over a 3- or 5- year time period to provide an indication of trends but avoid a focus on potentially inaccurate years when data were incomplete. The location of major cultural water uses are shown on a map of each basin based on a 2004 land cover study by the USGS that was supplemented, as needed and known, by the Department.

Effluent generation data were compiled from several sources and presented for each basin. Effluent is potentially an important renewable resource for some areas, although its reuse may be difficult to achieve both logistically and economically, e.g. where a potential user is far from the wastewater treatment plant.

Water Adequacy Determinations

Developers of subdivisions outside AMAs are required to obtain a determination from the Department of whether there is sufficient water of adequate quality for 100 years. If the supply is determined to be inadequate, lots may still be sold, but the condition of the water supply must be disclosed in promotional materials and in sales documents. In addition to these subdivision determinations, water providers may apply for adequacy designations for their entire service area. In the planning area the service areas of the Empirita Water Company and the Cities of Benson, Douglas, Willcox, and Safford have been designated as having an adequate water supply. If a subdivision is to be served water from one of these water providers, then a separate adequacy determination is not required.

Water adequacy and inadequacy determinations are tabulated and shown on maps for subdivisions not served by a designated water provider. Data are presented for each basin and include the name and location of the subdivisions, the number of proposed building lots, the date and result of the Department's determination, the reason(s) for inadequate determinations, and the water provider if listed at the time of the adequacy application. Among the reasons cited by the Department for inadequate determinations is a physical or legal lack of water, water quality concerns, and/or insufficient data for the Department to make its determination.

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